

## Special Session

### Comparative analysis of motorcycle utilization and forecasting model of motorcycle ownership of Eastern Asian Countries – Taiwan, Malaysia and Vietnam

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### The 6th International Conference of Eastern Asia Society for Transportation Studies

Date: 21-24 September, 2005

Venue: Queen Sirikit National Convention Center



## COMPARATIVE STUDY ON MOTORCYCLE OWNERSHIP FORECASTING MODEL OF ASIAN COUNTRIES – TAIWAN, MALAYSIA AND VIETNAM

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### 1. Introduction

High motorcycle ownership is a typical motorization situation of Asian countries comparing to Western countries who has higher car ownership than motorcycle ownership, as shown in Table 1.

Table 1. Car ownership and motorcycle ownership of selected countries

year	Car per 1000 people		Motorcycle per 1000 people	
	1990	2002	1990	2002
Austria	387	494	71	74
Belgium	385	464	14	30
canada	468	559	12	0
Denmark	320	360	9	15
Finland	386	419	12	43
France	405	491	55	-
Germany	386	516	18	56
Italy	476	542	45	125
Netherlands	368	384	44	25
New Zealand	436	613	24	21
Norway	380	417	48	61
Switzerland	449	507	114	102
United Kingdom	341	384	14	3
United States	573	481	17	15
china	1	7	3	26
Japan	283	428	146	106
Korea	48	205	32	59
Malaysia	101	204	167	238

Philippines	7	9	6	18
Thailand	14	35 (1999)	86	216 (1999)
Vietnam	3.82	7.94	45	138
Taiwan	106	217	351	532
Poland	138	259	36	21
Portugal	162	426	5	55
Czech Republic	228	356	113	74
Spain	309	441	79	80
Turkey	34	66	10	15

In Asian countries, even the car ownership is not so high like developed Western countries, however, the people have high mobility by using motorcycle, especially, in the high economic growing countries, as shown in Table 2.

Table3 The motor vehicle ownership and socio-economy of Asian countries

Countries	GDP per capita (US\$)	Car No.	Motorcycle No.	Motorcycle Ownership (Motorcycle per 1000 people)	Car Ownership (Car per 1000 people)	Data of Year
Taiwan	14,032	5,156,760	12,334,830	545.68	228.13	2003
China	1,100	14,788,100	43,307,700	33.61	11.48	2003/2001
Malaysia	3,984	5,001,273	5,842,617	235.83	201.87	2002
Vietnam	400	774,000	13,735,000	168.91	9.52	2004
India	551	8,619,000	47,525,000	44.65	8.10	2003
Thailand	2,224	2,880,893	18,210,454	293.65	46.46	2003
Philippine	1,081	739,170	1,552,570	19.05	9.07	2003
Indonesia	902	3,403,433	17,002,140	79.20	15.85	2002
Japan	33,819	42,624,000	13,369,191	104.80	334.11	2003

Information source: The World Bank Website Saffron Walden, Essex, England: World of Information-Asia & Pacific review 2005

To understand the reason why the Asian countries have high motorcycle ownership and then try to make forecasting will help creating better transportation policy. Furthermore, to expect the decline of motorcycle ownership will be considerable, but whether it can be described by the model or not, needs to be investigated.

According to the Japanese experience, the motorcycle will be growing with the economic first, and then declining when the income reaches a certain high level. However, the car ownership will keep on growing, as shown in Fig. 1.

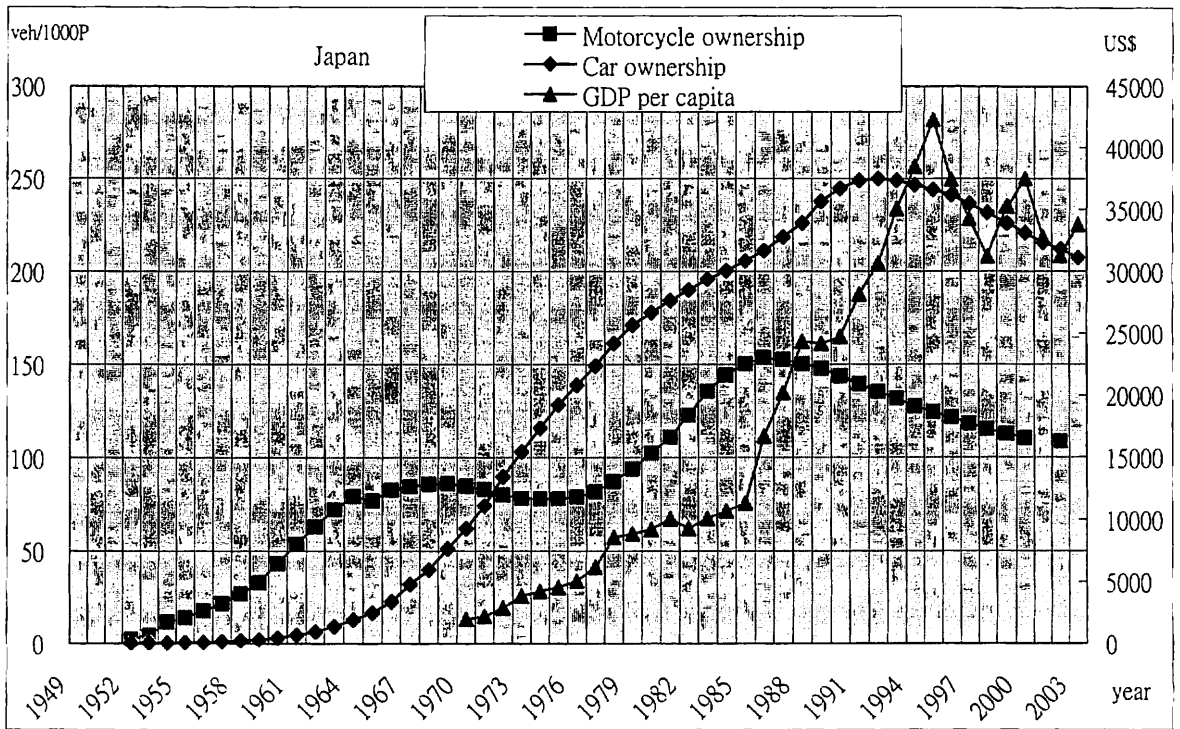


Figure 1: Private car ownership and two-wheeler ownership and GDP per capita

However, in Taiwan, the motorcycle ownership has not declined with the high income situation with more than 10,000 US\$ per capita, as shown in Fig.2. The reasons will be complicated and need to be investigated.

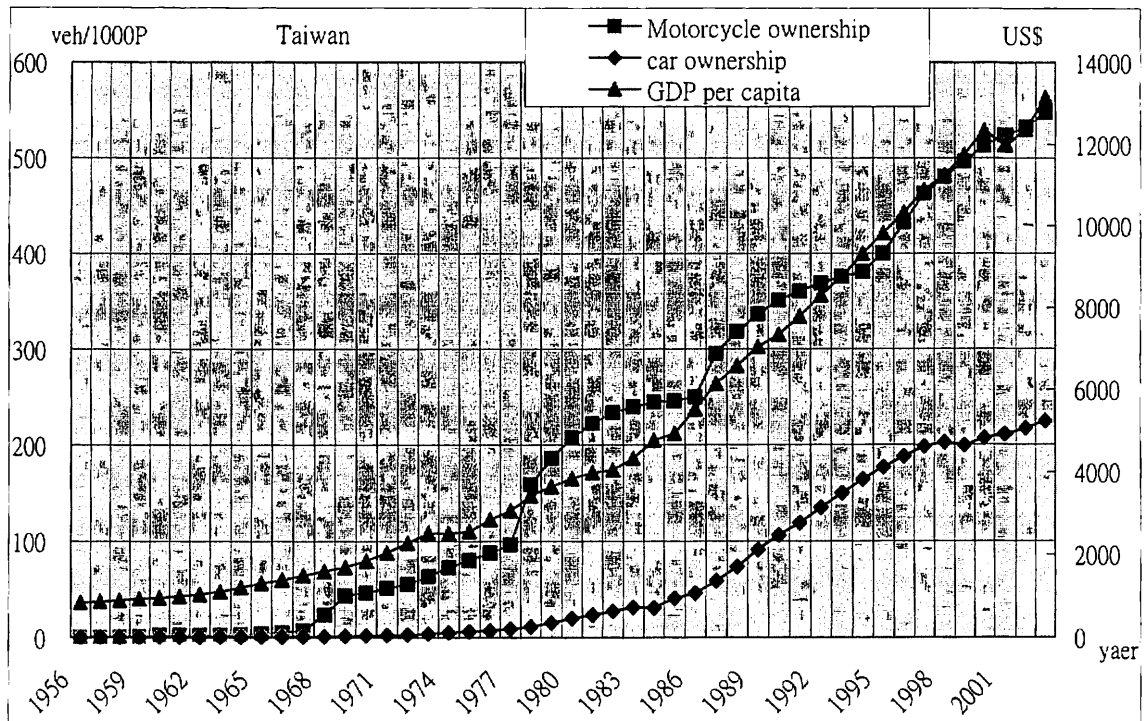


Figure 2: Car ownership and motorcycle ownership and GDP per capita of Taiwan

Using the data of Vietnam, China (low income and high growth rate), Malaysia (medium income and high growth rate), Taiwan (medium-high income and fair growth rate) and Japan (high income and low growth rate) as example to illustrate the characteristics of motorcycle ownership will be useful for understanding the Asian situation. If the data of the other countries can be obtained, the same analysis can be conducted too for understanding more about the difference of different countries.

## 2. Typical model types.

### 2.1 Ownership parameter of vehicles per thousand people

There are three scales for analyzing vehicle ownership, which are national level, regional level, and local (town) level. This study concerns national level for understanding the special situation of Asian countries.

The analysis can be made with aspect of individual or household basis. It is the vehicle owner choice model. It can be logistic model or household basis choice model. The analysis of vehicle ownership can be made also with aspect of ownership per thousand people with macroscopic viewpoint. With the household basis, the choice reason can be investigated and then the strategies for influencing the ownership of individual can be created. However, to understand the national development situation and then to make the comparison in different countries of forecasting model can be conducted using the macroscopic level. Therefore, in this comparative study, the macroscopic analysis of vehicle ownership per thousand people is taken as the parameter.

## 2.2 Regression model or S-shape tendency model

For understanding the factors influence on the vehicle ownership and then to creating forecasting model, the regression model is the most popular applied method, However, it needs to forecasting all independent variables for application to make forecasting. The another method is to fitting the curve of growing tendency. The S-shape logistical curve is the typical model. The saturation level can be estimated and then the curve can be created to make forecasting extrapolate to the future. The concept is illustrated in Fig. 3 and Fig. 4.

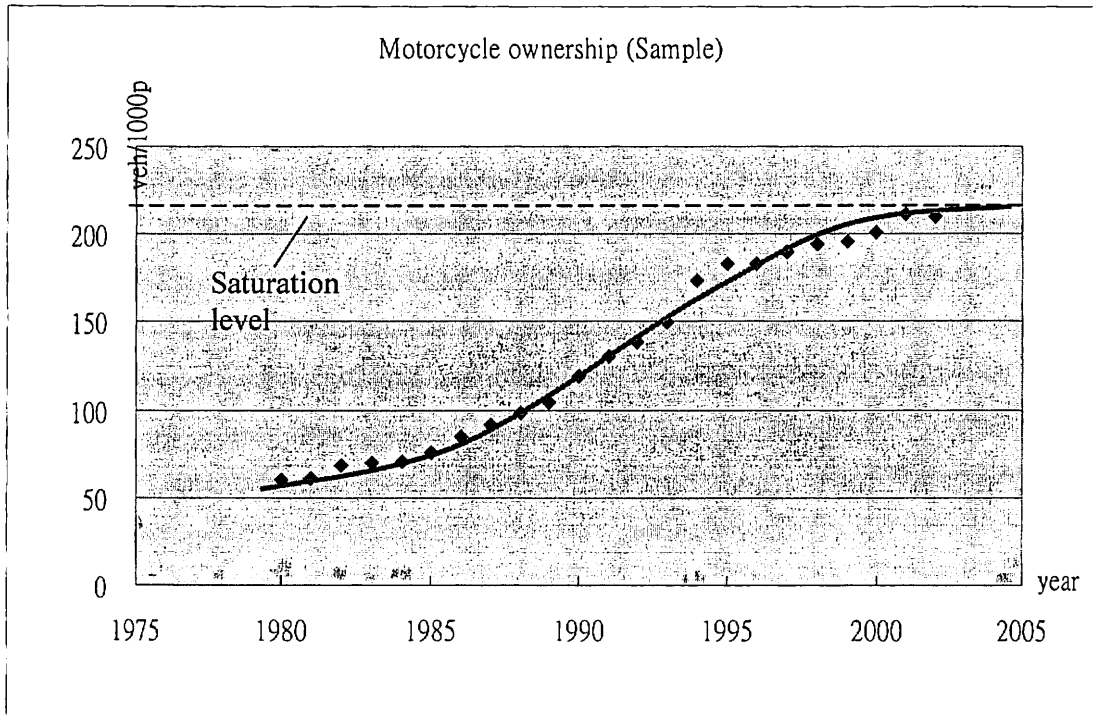


Figure 3. Virtual example of a S-shape motorcycle ownership growing tendency

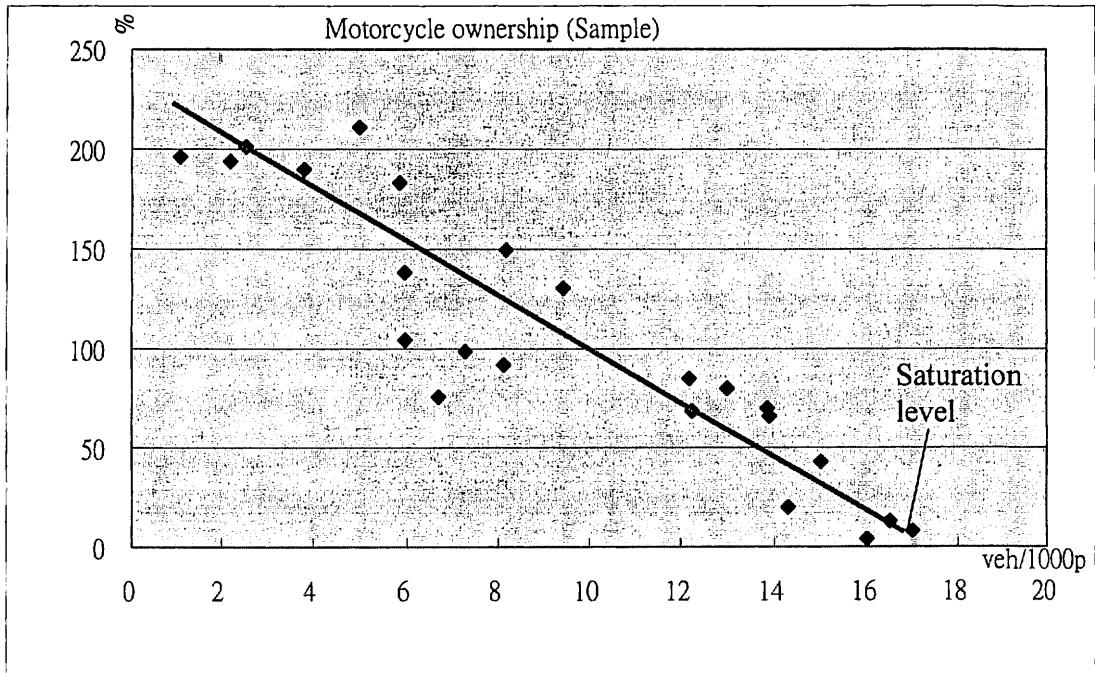


Figure 4. The virtual example to estimate the saturation level of vehicle ownership.

However, if the tendency doesn't follow the S-shape and the saturation level can't be estimated, the model will not be able to be created. The Fig. 5 shows the car ownership saturation levels could be able to be estimated due to the tendency is simple.

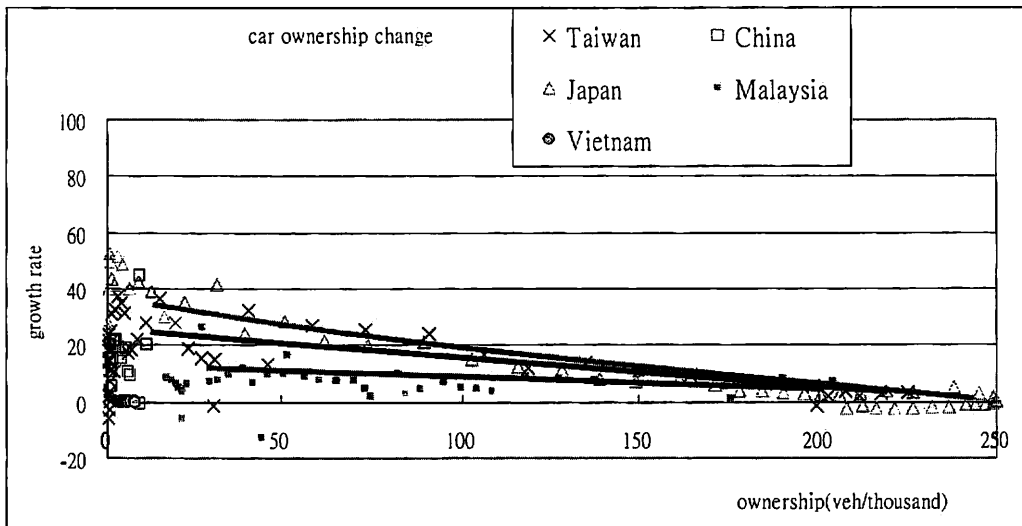


Figure 5. The saturation level of car ownership of linear extrapolation.

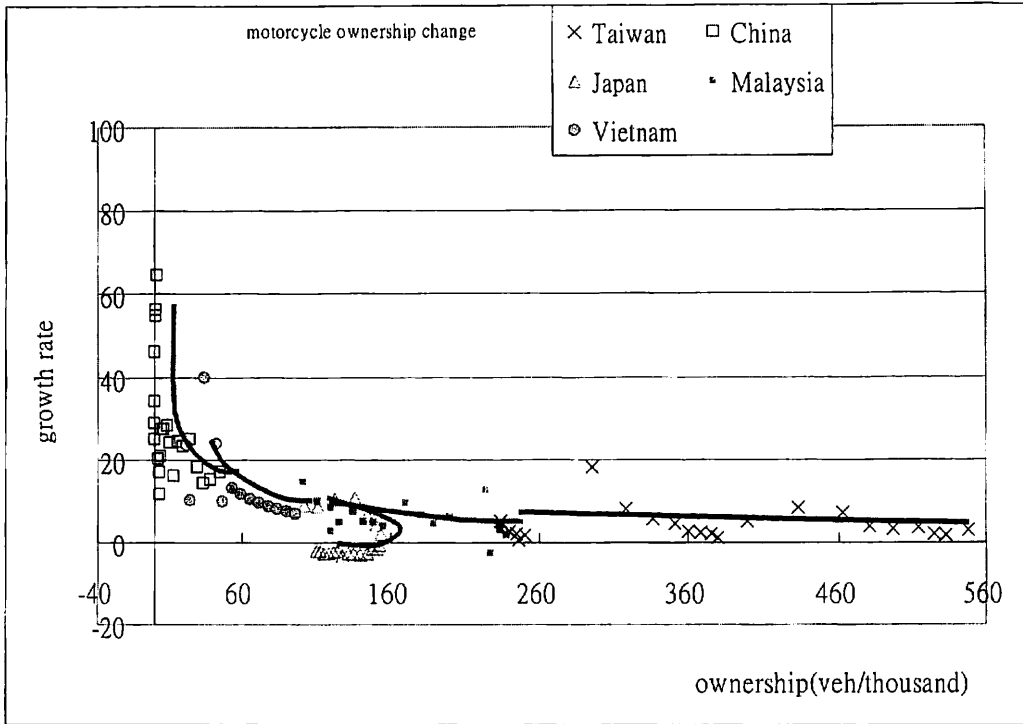


Figure 6. Motorcycle ownership saturation level with non-linear extrapolation

The S-shape curve for motorcycle ownership is not suitable in modeling the motorcycle ownership for the countries in this study, as shown in Table 4, which is the statistical analysis result in the very low and unreasonable curve fitting negative R-square value.

$$CO = \frac{a}{1 + b \exp(-cT)} \quad (1)$$

$$MO = \frac{a}{1 + b \exp(-cT)} \quad (2)$$

Table 4: S-shape logistic curve fitting result

Development variable	a	b	c	R-square
MO	-287.65067	-118.00819	-4.3654323	-1.08999
CO	-321.74305	-51.847042	-2.9103493	-.57421

The Gompertz model is tried successfully in this study, therefore, it will be used and described below.

### 3. THE INFLUENCE FACTORS

#### 3.1 Model and variables

All possible variables relating to the economic and transportation system could be considered in the model. If they can pass the statistical significant, then they can be involved into the model. However, it will reduce the practical usage of the model. For



example, according the research of vehicle ownership of car and motorcycle by the Institute of Transportation in 2000, the multi-regression model is as following:

Car number (car), number of household (nh) total passenger number of highway transportation (mht), Annual average expenditure of transportation, population (aet), and the removed variables through statistical test such as: passenger-kilometers of highway transportation, operating mileage of highway transportation mileage of highway, Commodity Tax of car, Commodity Tax of motorcycle, number of household, population of age of 15-64, population of employment, GDP, National Income, disposable income, Economic Growth Rate, Wholesale Price Index (WPI), Consumer Price Index (CPI). Through the statistical test, the regression model of motorcycle number is

$$\text{Motorcycle number} = -6419052 - 1901.887(\text{car})^{1/2} - 1.0651 - 07(\text{mht})^2 + 2.805(\text{nh}) + 22320.658(\text{aet})^{1/2}$$

It is impossible to be applied for make forecasting.

Therefore, in this paper, through the relationship analysis, the parameters selected are the economic and demographical data. The model is built in three groups. The first group is built with the national gross product values. The second group is built with the occupation structure of economic sectors. The third group is built with the simple GDP parameters. All models are proven statistical effective, as shown in Table 5.

Table 5: The parameter considered in this paper

Group of variables	Variable considered into model
Group I	Population, GDP per capita, Industrial Structure shared on GDP, Secondary, Industrial Structure shared on GDP, Tertiary, Urbanization population ratio
Group II	Population, GDP per capita, Employed Person by Industry, Secondary
Group III	Car ownership, GDP per capita

The regression analysis was mainly used to analyze the correlation between two variables at least. The purpose of regression analysis was to build a correlation between a dependent variable (Y) and a group of independent variables.

The linear multi-regression model composed of a dependent variable Y and m independent variables was showed that as follows.

$$(1) Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_m x_m + \varepsilon$$

If we have n samples, it would be showed that as follows.

$$(2) \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_m \end{bmatrix} = \begin{bmatrix} \beta_0 + \beta_1 x_{11} + \beta_2 x_{21} + \dots + \beta_m x_{m1} + \varepsilon_1 \\ \beta_0 + \beta_1 x_{12} + \beta_2 x_{22} + \dots + \beta_m x_{m2} + \varepsilon_2 \\ \vdots \\ \beta_0 + \beta_1 x_{1n} + \beta_2 x_{2n} + \dots + \beta_m x_{mn} + \varepsilon_n \end{bmatrix}$$

The stepwise method was used to select the variables. The selection criteria are set the

level of signification of 0.05 to select the independent variables. The variables considered in the model are GDP per capita, Urbanization population ratio, GDP shared of economic sectors and occupation proportion of economic sector, population density, and geographic latitude etc.

### 3.2 Model comparison among countries

There are different regression models found out for different countries, including different significant influence variable and different coefficients. Table 6 illustrates the models of Vietnam, Malaysia, and Taiwan. All the R-square of models are over 0.95.

Table 6: Regression models of the countries

Country	Model of variable group	Variable	R-square
Taiwan	I	1. GDP: GDP per capita 2. ISS_S: Industrial Structure shared on GDP , Secondary 3. ISS_T: Industrial Structure shared on GDP ,tertiary	0.989
	II	1. POP: Population (10 thousand) 2. EPI_S: Employed Person by Industry ,Secondary	0.986
	III	1. CO: Car ownership 2. GDP: GDP per capita	0.986
3.GDP: GDP per capita		0.965	
Malaysia	I	1. POP: Population (10 thousand) 2. ISS_S: Industrial Structure shared on GDP , Secondary 3. URB: Urbanization population ratio	0.959
	II	1.POP: Population (10 thousand)	0.923
	III	1. CO: Car ownership 2. GDP: GDP per capita	0.980
3. GDP: GDP per capita		0.956	
Vietnam	I	1. GDP: GDP per capita	0.958
	II	1.GDP: GDP per capita 2. EPI_S: Employed Person by Industry ,Secondary	0.985
	III	1. CO: Car ownership 2. GDP: GDP per capita	0.983
1. GDP: GDP per capita		0.967	

The formula of the regression models are illustrated in Table 6. All models have the R-square of more than 0.95 and high enough statistical significance. For Taiwan, the model with highest R-square is the model come out from input of variable group I. The variables include GDP per capita, industrial structure shared on GDP (secondary), and industrial structure shared on GDP (tertiary). For Malaysia, the model with highest

R-square is from group III, which includes the variables of car ownership and GDP. The model with highest R-square is from group II, which includes variables of GDP per capita and employed population proportion of second economic sector.

Table 7. Regression models of countries

Country	Variable Group	Model	R-square
Taiwan	I	$MO = -601.996 + 0.021x \text{ GDP} + 7.775x \text{ ISS\_S} + 10.385x \text{ ISS\_T}$	0.989
	II	$MO = -1078.38 + 0.777x \text{ POP} - 3.907x \text{ EPI\_S}$	0.986
	III	$MO = -72.583 - 1.294x \text{ CO} + 0.072x \text{ GDP}$	0.986
$MO = 0.02495 x \text{ GDP}^{1.05957}$		0.965	
Malaysia	I	$MO = -44.85 + 0.14x \text{ POP} + 4.918x \text{ ISS\_S} - 3.193x \text{ URB}$	0.959
	II	$MO = -108.434 + 0.147x \text{ POP}$	0.923
	III	$MO = 21.943 + 0.940 x \text{ CO} + 0.01x \text{ GDP}$	0.980
$MO = 0.360 x \text{ GDP}^{0.767}$		0.956	
Vietnam	I	$MO = -104.43 + 0.629x \text{ GDP}$	0.958
	II	$MO = -158.31 + 0.507x \text{ GDP} - 6.618x \text{ EPI\_S}$	0.985
	III	$MO = -70.26 + 31.273x \text{ CO} - 0.127x \text{ GDP}$	0.983
$MO = 0.0001245 x \text{ GDP}^{2.34046541}$		0.967	

The signs of coefficients are different from the countries. That means the influence tendency by same variable is different. By using the variables of group I, which are population density, GDP per capita, urbanization population ratio, and proportion of industrial structure shared on GDP for modeling stepwise regression, the motorcycle ownership is positively related to GDP, proportion of industry shared on GDP in the model of Taiwan. It is positively related to population, proportion of industry and service industry shared on GDP, and negative related to urbanization population ratio in the model of Malaysia. In Vietnam, it is only positive related to GDP.

When using the variable of group II, which are population density, GDP per capita, urbanization population ratio, and proportion of industrial structure shared on employed persons for the stepwise regression, the motorcycle ownership is positive related to population, proportion of industry shared on employed persons in the model of Taiwan. It is only positive related to population in Malaysia model. In Vietnam, it is positive related to GDP and proportion of industry shared on employed persons.

Table 8. Regression models of Asia countries

Model of Group	constant		Population (10 thousand)		GDP per Capital		Industrial Structure shared on GDP, Secondary (%)		Industrial Structure shared on GDP, tertiary (%)		Urbanization(%)		R Square
	Coefficients	P-value	Coefficients	P-value	Coefficients	P-value	Coefficients	P-value	Coefficients	P-value	Coefficients	P-value	
Taiwan, 1	-601.996	<.0001	-	-	0.021	0.023	7.775	<.0001	10.385	0.011	-	-	0.989
Malaysia, 1	-44.85	<.0001	0.14	0.001	-	-	4.918	0.001	-	-	-3.193	0.022	0.959
Vietnam, 1	-104.43	<.0001	-	-	0.629	<.0001	-	-	-	-	-	-	0.958
Model of Group	constant		Population (10 thousand)		GDP per Capital		Employed Person by Industry, Secondary(%)						R Square
Taiwan, 2	-1078.38	<.0001	0.777	<.0001	-	-	-3.907	<.0001					0.986
Malaysia, 2	-108.434	<.0001	0.147	<.0001	-	-	-	-					0.923
Vietnam, 2	-158.31	<.0001	-	-	0.507	<.0001	6.618	0.002					0.985
Model of Group	constant		Car ownership		GDP per Capital								R Square
Taiwan, 3-1	-29.502	<.0001	-	-	4.668E-02	<.0001							0.974
Taiwan, 3-2	-72.538	<.0001	-1.294	<.0001	7.194E-02	<.0001							0.986
Malaysia, 3-1	25.122	.011	-	-	4.691E-02	<.0001							0.862
Malaysia, 3-2	21.943	<.0001	0.940	<.0001	1.03E-02	0.003							0.980
Vietnam, 3-1	-104.430	<.0001	-	-	0.629	<.0001							0.958
Vietnam, 3-2	-70.260	<.0001	31.273	<.0001	-0.127	0.461							0.986

Dependent Variable: mo

#### 4 Gompertz Model

Gompertz model is a nonlinear regression model with probability model type. Because the ownership of motorcycle could also have the characteristic of saturation level, Gompertz model would be suitable for building motorcycle ownership forecasting model.

The basic form of Gompertz nonlinear regression model is:

$$C = \gamma \cdot e^{\alpha \cdot e^{\beta Y}} \dots\dots\dots (3)$$

Equation (1) can be used to model long term forecasting model of vehicle ownership. The variable to influence the vehicle ownership can be the income, Y. The parameter  $\gamma$  is the saturation level of vehicle ownership,  $\alpha$  and  $\beta$  are parameters to represent the curvature type of the function, and e means natural logarithm, Y is influence variable.

According to the formula form of Gompertz model, the vehicle ownership will increase with the influence factor first, and thereafter, the increasing margin will become low gradually. So it supposes the vehicle ownership will reach a saturation level, and in this condition, the increase of influence variable will not more influence the vehicle ownership. The vehicle ownership could be little increasing or decreasing, but in the whole, the average vehicle ownership will not change. So, if the value of influence variable is growing infinitely, the vehicle ownership will near to saturation level. It can be show as equation (4):

$$\lim_{Y \rightarrow \infty} C = \gamma \dots\dots\dots (4)$$

On the other hand, as the value of influence variable Y is very small, the vehicle ownership can be shown as equation (5):

$$\lim_{Y \rightarrow 0} C = \gamma \cdot e^{\alpha} \dots\dots\dots (5)$$

Because there are some other factors affecting the vehicle ownership, it is not increasing directly as the influence variable Y. This phenomenon can be described by setting the variable of vehicle ownership of deferred period. After testing, we find the model will become more accurately if add the deferred term in it. So the adjust term of  $\theta$  is added into the model to reflect the deferred influence. The vehicle ownership model is adjusted and as equation (6):

$$C_t = \gamma \cdot \theta \cdot e^{\alpha \cdot e^{\beta Y_t}} + (1 - \theta)C_{t-1} \dots\dots\dots (6)$$

#### 4.1 Time deferred parameter ( $\theta$ ) test

After testing with different values of  $\theta$ (from 0.1 to 0.9 step 0.1), it is found when the parameter  $\theta=0.1$ , the Taiwan motorcycle ownership model has better result, and the saturation level of motorcycle ownership from prediction is 609.19 motorcycles per 1000 people. The model has a high performance of R-square of  $R^2=0.99696$ ; The Taiwan car ownership model has better result when  $\theta=0.3$ , and the saturation level of car ownership from prediction is 246.48 vehicles per 1000 persons. The model also has a high performance of R-square,  $R^2=0.99927$ .

Table 9 Gompertz Model-Taiwan motorcycle ownership

	$\alpha$	$\beta$	$\gamma$	R-square
$\theta=0.0$	-5.0000000	-.00100000	500.000000	.99221
<b><math>\theta=0.1</math></b>	<b>-4.5294973</b>	<b>-.00049608</b>	<b>609.195294</b>	<b>.99696</b>
$\theta=0.2$	-4.3571252	-.00040589	555.864184	.99658
$\theta=0.3$	-4.3940473	-.00038090	539.651089	.99576
$\theta=0.4$	-4.4357319	-.00036957	531.793484	.99448
$\theta=0.5$	-4.4693595	-.00036318	527.140863	.99275
$\theta=0.6$	-4.4957214	-.00035910	524.058760	.99055
$\theta=0.7$	-4.5166114	-.00035628	521.864824	.98789
$\theta=1.0$	-4.5588347	-.00035141	517.924345	.97715

Table 10 Gompertz Model-Taiwan car ownership

	$\alpha$	$\beta$	$\gamma$	R-square
$\theta=0.1$	-23.888844	-.00065488	276.165918	.99911
$\theta=0.2$	-12.873585	-.00046443	247.458897	.99926
$\theta=0.3$	-10.697141	-.00039701	246.482266	.99927
$\theta=0.4$	-9.9499942	-.00036536	248.986675	.99922
$\theta=0.5$	-9.6162583	-.00034753	251.692387	.99912
$\theta=0.6$	-9.4440445	-.00033628	254.046733	.99897
$\theta=0.7$	-9.3470423	-.00032860	256.007073	.99876
$\theta=0.8$	-9.2892351	-.00032306	257.630148	.99850
$\theta=0.9$	-9.2535487	-.00031890	258.981818	.99819
$\theta=1.0$	-9.2310778	-.00031566	260.118101	.99783

Table 11: Gompertz Model-Malaysia motorcycle ownership

	$\alpha$	$\beta$	$\gamma$	R-square
$\theta=0.0$	-5.0000000	-.00100000	500.000000	.98105
<b><math>\theta=0.1</math></b>	<b>-2.9472940</b>	<b>-.00045239</b>	<b>398.839776</b>	<b>.99580</b>
$\theta=0.2$	-3.0743609	-.00057447	263.137488	.99126
$\theta=0.4$	-3.2453675	-.00065816	210.808519	.97330
$\theta=0.6$	-3.3292885	-.00069092	195.202905	.94343

Table 12: Gompertz Model-Malaysia car ownership

	$\alpha$	$\beta$	$\gamma$	R-square
$\theta=0.0$	-5.0000000	-.00100000	500.000000	.97931
$\theta=0.1$	<b>-2.0928596</b>	<b>-.00031472</b>	<b>531.206674</b>	<b>.99387</b>
$\theta=0.2$	-2.1306608	-.00049994	323.581343	.99185
$\theta=0.3$	-2.2464997	-.00057894	281.585976	.98731

#### 4.2 Saturation level value of vehicle ownership

Because the development stages in different countries are not similar, Gompertz model in some countries can't get the reasonable result of saturation level, for example in China and Vietnam. It needs to set the saturation level value in the model.

Under the assumption that everyone who can get the drive license will have a motorcycle, the saturated value of motorcycle ownership is about the proportion of population of age greater than 18 to whole population. The proportion of population of age greater than 18 to whole population in Taiwan is 73.645% in year 2004, so it is assumed saturation level of motorcycle ownership is about 750 vehicles per 1000 persons. The saturation level of car ownership can refer to the recent development in Japan, the saturation level of car ownership is about 350 vehicles per 1000 people. And it will be little growing in the future, therefore assuming the saturation level of car ownership for Asian countries to be 450 vehicles per 1000 people.

#### 4.3 Result of Gompertz model

By trying to build the Gompertz model of five countries, Japan, Taiwan, Malaysia, Vietnam and China. According to the result, following characteristics are concluded, as shown in Table 13 and 14:

1. In Taiwan, Gompertz model find the saturated value of car in searching saturation level is 249 vehicles per 1000 people, and the saturation level of motorcycle is 609 vehicles per 1000 people. The motorcycle ownership in Taiwan now is over 543 vehicles per 1000 people. According to the prediction of model, the motorcycle ownership will reach the saturation level in ten years.
2. In China and Vietnam, Gompertz model can not find the saturation level in searching saturation level model, because their number of cars and motorcycles are in a rapid growth stage. It cannot match with the assumption of Gompertz model.
3. In Japan, Gompertz model finds the saturated value of 129 motorcycles per 1000 people in searching saturation level of model. The highest value was 159 motorcycles per 1000 people in 1997, and it is down to 109 vehicles per 1000 people now.
4. Gompertz model find the saturation level in Taiwan is 609 motorcycles per 1000 people. It is greater than 339 motorcycles per 1000 people in Malaysia and 129 motorcycles per 1000 people in Japan.
5. Under the Assumption of 3% GDP growth rate for Taiwan, the prediction of motorcycle ownership by Gompertz model by setting saturation level and searching saturation level in

2010 will reach 618 motorcycle and 591 motorcycles per 1000 people. And it will reach 690 motorcycles and 650 motorcycles per 1000 people in 2030.

Table 13 Gompertz model of motorcycle ownership in different countries

Country	Saturation level	$\alpha$	$\beta$	$\gamma$	R-square
China	Search*	-	-	-	-
	Set	-6.3349356	-0.00009600	750	0.9828
Taiwan	Search	-4.5294973	-0.00049608	609.195	0.99696
	Set	-3.38798	-0.00020350	750	0.9619
Malaysia	Search	-2.9472940	-0.00045239	398.840	0.99580
	Set	-3.3394917	-0.00019480	750	0.9220
Vietnam	Search*	562.817970	-0.40013769	489070.42	0.7691
	Set*	643.202475	-0.45689465	750	-1.7133
Japan	Search	-1.3596784	-0.00027405	129.610	0.8387

\*:1. Analysis tool: SPSS statistics analysis software

2. Gompertz model can't convergence in searching saturated value model.

3. The trend of motorcycle growth in Vietnam is against the assumption of Gompertz model, so it can not find a reasonable result.

Table 14 Parameters of Gompertz model in different countries

Countries	$\alpha$	$\beta$	$\gamma$	R-square	Reasonable model found
Japan	-1.3596784	-0.00027405	129.609931	0.8387	o
Taiwan	-4.5294973	-0.00049608	609.19529	0.9970	o
Malaysia	-2.9472940	-0.00045239	398.83978	0.9958	o
Vietnam	-	-	-	-	no
China	-	-	-	-	no

The model estimated value and exiting value are illustrated in Fig. 10



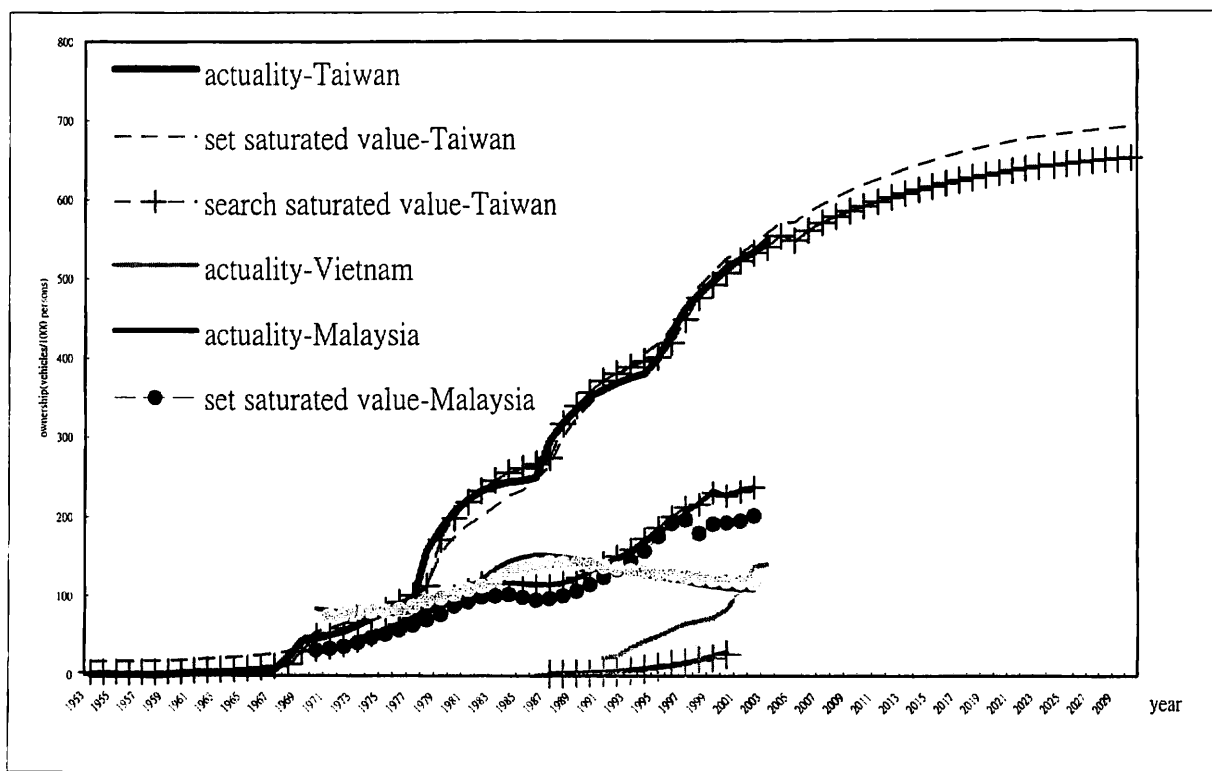


Figure 10: The actual and forecasting motorcycle ownership of different countries

## 5.CONCLUSION

Different countries will have different development stage and then different model of forecasting the motorcycle ownership. The motorcycle ownership in developing countries is growing very rapid. Using the tendency model or regression model will cause the expected number of motorcycle in the future become very huge. How to predict the decrease of motorcycle ownership will become the important issue in the future. The forecasting model developed in the developed countries or in the countries with higher income level should be taken as the reference if we want to build a more accurate model for forecasting future motorcycle ownership of developing countries.

## **MOTORCYCLE OWNERSHIP AND UTILITY ANALYSIS BY QUESTIONNAIRE SURVEY – TAIWAN, VIETNAM AND MALAYSIA**

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### **1. Introduction**

This survey aims to investigate vehicle ownership and usage characteristics and furthermore, to provide data to create prediction model. The questionnaire is conducted in the major motorcycle city in each investigated countries. In Taiwan, it is conducted in the city center of Taipei metropolitan. In Vietnam, it is conducted in Hanoi city center. In Malaysia, it is conducted in the major motorcycle high ownership city Penang. The sample is randomly select on the street. The sample size is requested at least 300 for the level of significance of 0.05 and error less than 5%. The sample size conducted in Taipei is 393 interviewee; in Vietnam is 536 interviewee; and in Malaysia is 435. The survey is conducted by Hsu in Taiwan, by Dao in Vietnam and by Ahman Farhan in Malaysia. The survey is including vehicle own and use information and personal information of the car or motorcycle owner and household.

### **2. Respondent's background statistics of Taiwan and Vietnam**

#### **2.1 Gender, Age and Occupation**

In Taiwan, usable questionnaires were obtained from 393 respondents, including 255(64.8%) men, and 138 (35.11%) women. About half of respondents' age are between 19 and 30, about 20% of them are between 30 and 40 years old. The majority of the respondents' occupation is commercial/service (37.2%) or student (31.6%) ; The income per month mostly locates between 20000-(33.8%) and 30000-40000(18.8%). About 2/3 of respondents live with their family together. The average commuting distance using motorcycle is 12.82 km. The average commuting time is 25.43 min and they spent in average about NT\$2033 in transportation every month.

In Vietnam, usable questionnaires were obtained from 536 respondents, including 264(49.6%) men and 272(50.4%) women. About 30% of respondents have age of

between 31 and 40, about 25% of between 41 and 50. Most of the respondents have the occupation of commercial/service (36.8%). Almost all respondents live with their family together. For all respondents, the average commuting distance is only 3.89 km, the average commuting time is about 15.2 min and they spent in average 398 thousand VND in transportation every month.

Table 1 Gender of respondent

Gender	Taiwan		Vietnam	
	Numbers	%	Numbers	%
Male	255	64.8	264	49.6
Female	138	35.2	272	50.7
Total	393	100	536	100

Table 2 Age of respondent

Age	Taiwan		Vietnam	
	Numbers	%	Numbers	%
19–30	206	52.4	118	22
31–40	73	18.6	149	27.8
41–50	71	18.1	134	25
51–60	39	9.9	96	17.9
61+	4	1	39	7.2
Total	393	100	536	100

Table 3 Occupation of respondent

Occupation	Taiwan		Vietnam	
	Numbers	%	Numbers	%
Agriculture	4	1.02	95	17.7
Industry	38	9.67	130	24.3
commercial/service	146	37.15	197	36.8
government/military	52	13.23	114	21.3
Student	124	31.55	0	0
Other	29	7.38	0	0
Total	393	100	536	100

Table 4 Income per month of respondent

Taiwan			Vietnam		
Income per month(NT)	Numbers	%	Income per month (1000 VND)	Numbers	%
20000—	133	33.8	20000—	124	23.1
20000—30000	55	14	20000—30000	107	20
30000—40000	74	18.8	30000—40000	44	8.2
40000—50000	40	10.2	40000—50000	44	8.2
50000—60000	36	9.2	50000—60000	57	10.6
60000—70000	22	5.6	60000—70000	46	8.6
70000+	31	7.9	70000+	114	21.3
No answer	2	0.5	No answer	0	0
Total number and %	393	100	Total number and %	536	100

Table 5 resident condition of respondent

Live with family	Taiwan		Vietnam	
	Numbers	%	Numbers	%
Yes	258	65.7	536	100
No	122	31	0	0
No answer	13	3.3	0	0
Total	393	100	536	100

## 2.2 Vehicle Owning and usage statistics Analysis

As shown in Table 6, the most of the respondents' in Taiwan only own the motorcycle. It is 50.6%. In Vietnam, 98.7% of respondents have only motorcycle(s).

Table 6 Vehicle owning condition

Vehicle Owning	Taiwan		Vietnam	
	Numbers	%	Numbers	%
only own motorcycle(s)	199	50.6	529	98.7
only own car(s)	73	18.6	3	0.6
own both motorcycle(s) and car(s)	121	30.8	4	0.7
Total number and %	393	100	536	100

### (1) Only own motorcycle(s)

As shown in Table 7 and Table 8, the number of motorcycle owned by one person is most only one motorcycle owned by one person. It is more than 90% of respondents in Taiwan own one motorcycle. The major reason to only own motorcycle is "Motorcycle has higher mobility than car" (90%) and "Motorcycle is easy on parking"(80.4%).

In Vietnam, about 98.5% respondents own one motorcycle. The major reason why they only own motorcycle is “Car too expensive”(100%) and “Motorcycle is easy on parking”(20.6%).

Table 7 Number of motorcycles owned

Owned number	Taiwan		Vietnam	
	Numbers	%	Numbers	%
1	186	93.9	521	98.5
2	11	5.6	8	1.5
3	1	0.5	0	0
Total	199	100	529	100

Table 8 Main factor of owning a motorcycle in Taiwan

Main factor ("1" is the most main factor )	1	2	3	4	5	6	Total	%
Car too expensive	40 (20.1%)	8	16	11	11	17	123	61.8
easy on parking	37 (18.6%)	50	32	18	9	4	160	80.4
low fuel consumption costs	12 (6.0%)	24	35	26	17	6	136	68.3
No convenient public transportation	15 (3.0%)	28	13	15	10	16	116	58.3
Higher mobility than car	77 (38.7%)	43	26	20	3	1	179	90
Commuting distance is short	18 (9%)	22	29	25	12	6	123	61.9

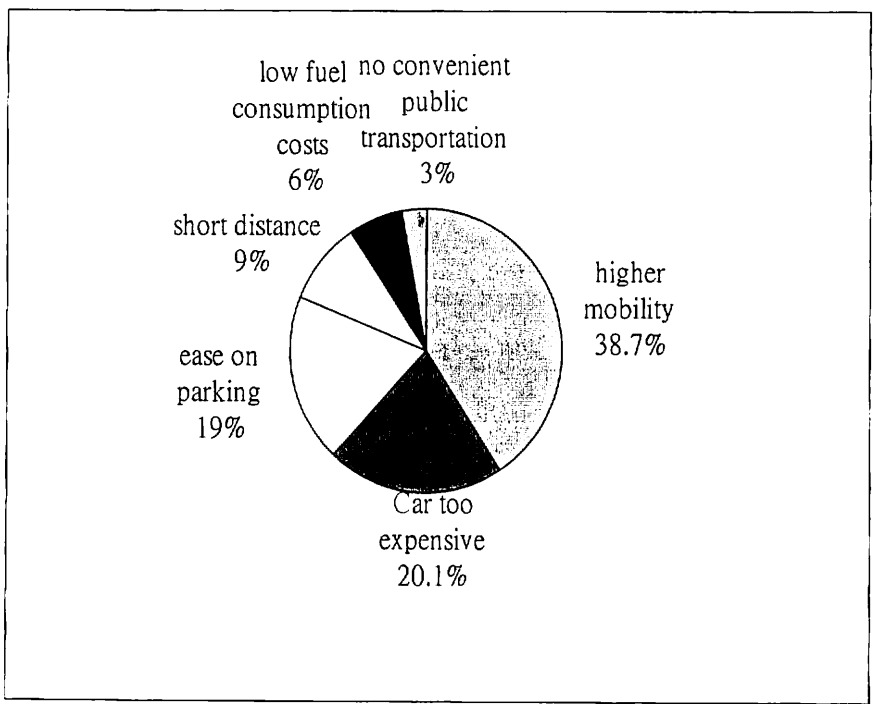


Figure1 Main factor of owning a motorcycle in Taiwan

Table 9 Main factor of owning a motorcycle in Vietnam

Main factor (“1” is the most main factor )	1	2	3	4	5	6	Total	%
Car too expensive	57 (39.3%)	0	0	86	192	194	529	100
easy on parking	12 (8.3%)	0	10	22	54	43	141	26.7
low fuel consumption costs	61 (42.1%)	0	0	12	10	37	120	22.7
No convenient public transportation	15 (10.3%)	43	0	0	0	10	68	12.9
Higher mobility than car	0 (0%)	15	0	43	0	0	58	11.0
Short commuting distance	0 (0%)	0	73	0	0	0	73	13.8

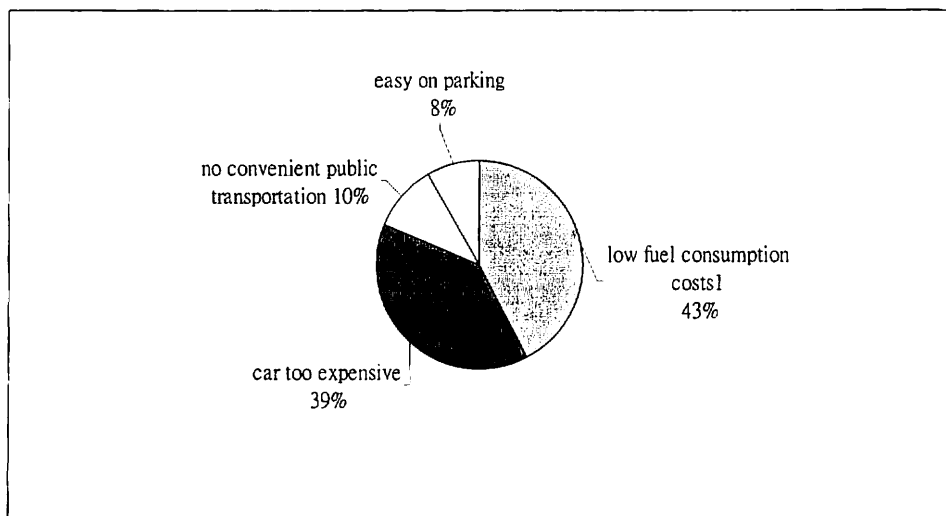


Figure 2 Main factor of owning a motorcycle in Vietnam

(2) Only own car(s)

As shown in Table 9 and Table 10, about 90% of respondents own only one car. The major reason most respondent owning only car is “Car is more comfortable”(68.5%) and “Car is saver”(65.8%). The priority order of reason why respondents only owning car is “Motorcycle is too dangerous”(20.5%)、Car needs for constant carpooling (17.8%)

Table 10 Number of cars owned in Taiwan

Owned number	Numbers	%
1	64	87.7
2	9	12.3
Total	73	100

Table 11 Main factor of owning a car in Taiwan

Main factor (“1” is the most main factor )	1	2	3	4	5	6	7	Total	%
Saver	21 (28.7%)	10	11	7	3	1	2	49	67.1
More comfortable	12 (16.4%)	13	9	8	4	3	1	50	68.5
No convenient public transportation	4 (5.5%)	6	5	5	5	4	1	30	41.1
Long commuting distance	10 (13.7%)	10	9	2	3	3	3	40	54.8
Needs for constant carpooling	13 (17.8%)	10	7	2	2	6	3	43	58.9
Needs for family recreational activities	12 (16.4%)	8	4	7	3	3	4	41	56.2

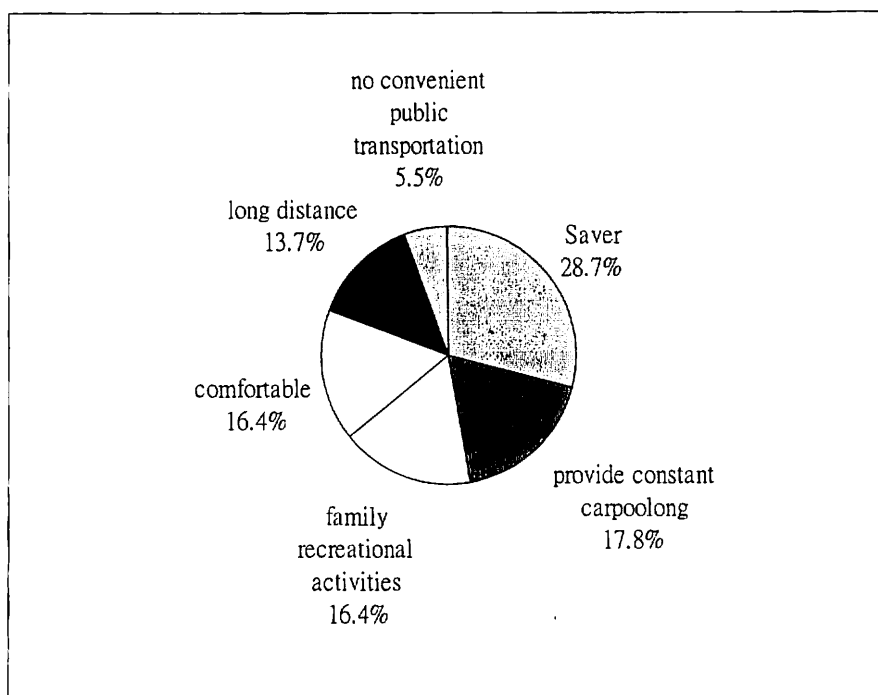


Figure 3 Main factor of owning a car in Taiwan

(3) Own both motorcycle(s) and car(s)

As shown in Table 11 – Table 14, the large majority of the numbers of respondents who own both car and motorcycle have only one car (89.3%) and one motorcycle (76.9%). Those respondents in average own 1.11 cars and 1.28 motorcycles. Among them, 82% of the respondents buy motorcycle first. About 70% respondents use motorcycles more often than take the car. Easy to park is one of the main reasons for using motorcycle but not using the car. However, if they consider on comfortable or they need to provide carpool for others, they will use the car : The main reason why the other 30% respondents use car more often than use motorcycle is they need to provide carpool for others. If they travel only short distance, they will use motorcycle.

Table 12 Number of cars and motorcycles owned in Taiwan

Owning number	Cars		Motorcycles	
	Numbers	%	Numbers	%
1	108	89.3	93	76.9

2	13	10.7	22	18.2
3	—	—	6	4.9
Total	121	100	121	100
Average 1.11 cars and 1.28 motorcycles owned per respondent				

Table 13 The sequence of owning vehicles in Taiwan

Sequence	Numbers	%
Car first	22	18.2
Motorcycle first	99	81.8
Total	121	100

Table 14 To use car or motorcycle as the first choice, the reasons, in Taiwan

Main reason	Car (28.1%)		Motorcycle (71.9%)	
	Numbers	%	Numbers	%
avoid traffic jam	3	8.8	41	47.1
ease on parking	5	14.7	56	64.4
Less fuel consumption	0	0.0	17	19.5
Free parking	0	0.0	13	14.9
Only short distance	2	5.9	35	40.2
Saver	12	35.3	3	3.5
More comfortable	13	38.2	0	0.00
Provide carpool for others	15	44.1	0	0.00
Total	34	—	87	—

Table 15 Not to use car or motorcycle, the reasons, in Taiwan

Main reason	Car (71.9%)		Motorcycle (28.1%)	
	Numbers	%	Numbers	%
avoid traffic jam	2	2.3	7	20.6
ease on parking	1	1.2	8	23.5
Less fuel consumption	0	0.0	3	8.8
Free parking	1	1.2	2	5.9
Only short distance	12	13.8	18	52.9
Saver	24	27.6	0	0.0
More comfortable	47	54.0	3	8.8
Provide carpool for others	48	55.2	0	0.0
Total	87	—	34	—

### 2.3 Expenditure and cost of vehicle owning and usage

For transportation mode usage and travel costs in Taiwan, 62.3% of Taiwanese respondents mainly use motorcycles everyday. The average commuting distance, by using car is about 19.53 km. Regarding the costs, car owners and rapid transit users



spend the most money for traffic, for around NT\$3000 every month, bicycle owners spent the least money for traffic, for Nt\$1130 every month.

In Vietnam, 96.8% respondents mainly use motorcycles everyday. The longest average commuting distance is about 6.9km by using car. They spend the longest average commuting time when using car, about 23.2 minutes. Regarding costs, car owners spend the most, for around \$600(1000 VVD) every month.

Table 16 Principal vehicle and expenditure on transportation in Taiwan

Vehicle	Number	Averaged commuting Distance (km)	Averaged commuting Time (min)	Spend in Transportation each month (NT)
Car	105 (27.2%)	19.53	24.08	3303
Motorcycle	240 (62.3%)	9.82	22.02	1423.37
Bicycle	9 (2.3%)	6.61	13.89	1130
Bus	6 (1.5%)	13.16	33.33	2166.67
Rapid Transit	21 (5.5%)	11.95	23.33	3104.76
Taxi	0 (0%)	—	—	—
Other	4 (1%)	38	46.25	1250

Table 17 principal vehicle and expenditure on transportation in Vietnam

Vehicle	Number	Averaged commuting Distance (km)	Averaged commuting Time (min)	Spend in Transportation each month (1000 VND)
Car	13 (2.4%)	6.9	23.2	600
Motorcycle	519 (96.8%)	3.56	12.8	395
Other	4 (0.7%)	0.5	7.8	387.5

#### 2.4. Owner of the vehicle analysis

In Taiwan, the vehicles used by respondents are owned by themselves. Most respondents themselves paid the vehicle by themselves. About 36.6% of motorcycle owners whose motorcycle are paid by their parents.

In Vietnam, most respondents pay for the vehicles by themselves.

Table 18 Owner of the vehicle in Taiwan

Who owns the vehicles they use	Car only	Motorcycle only	Both car and motorcycle
NO using vehicle	1 (1.4%)	2 (1.0%)	1 (0.8%)
Parents	10 (13.7%)	37 (18.6%)	14 (11.6%)
Myself	59 (80.8%)	153 (76.9%)	103 (85.1%)
Other	3 (4.1%)	6 (3.0%)	2 (1.7%)
No answer	0 (0.0%)	1 (0.5%)	1 (0.8%)
Total	73 (100%)	199 (100%)	121 (100%)

Table 19 Owner of the vehicle in Vietnam

Who owns the vehicle they use	Car only	Motorcycle only	Both car and motorcycle
NO using vehicle	0 (0%)	0 (0%)	0 (0%)
Parents	1 (33.3%)	8 (1.5%)	0 (0%)
Myself	2 (66.7%)	521 (98.5%)	4 (100%)
Other	0 (0%)	0 (0%)	0 (0%)
No answer	0 (0%)	0 (0%)	0 (0%)
Total	3 (100%)	529 (100%)	4 (100%)

Table 20 Who pays for the vehicle in Taiwan

Who pays for the vehicle	Car only	Motorcycle only	Both car and motorcycle
Myself	55 (93.2%)	94 (61.4%)	85 (82.5%)
Parents	1 (1.7%)	56 (36.6%)	16 (15.5%)
Other	3 (5.1%)	3 (2.0%)	2 (1.9%)
Total	59 (100%)	153 (100%)	103 (100%)

Table 21 Who pays for the vehicle in Vietnam

Who	Car only	Motorcycle only	Both car and motorcycle
Myself	2 (100%)	505 (96.9%)	4 (100%)
Parents	0 (0%)	16 (3.1%)	0 (0%)
Total	2 (100%)	521 (100%)	4 (100%)

## 2.5 Household information analysis

In Taiwan, most of the households have car and motorcycle at the same time, as shown in Table 22. For the people who have the personal income per month under \$20000NT, mostly students, the motorcycle is their only transportation mode. If their personal income is over \$40000NT per month, the number of household owning only motorcycles is significantly smaller than the number of household owning cars.

In Vietnam, most of families have only motorcycle, as shown in Table 23.

Table 22 Total family member number and vehicles distribution in Taiwan

No. of Family member	Motorcycle only	Car only	Both car and motorcycle
1	1 (1.8%)	2 (5.9%)	4 (1.3%)
2	13 (23.6%)	6 (17.7%)	18 (5.9%)
3	11 (20%)	3 (8.8%)	38 (12.5%)
4	20 (36.4%)	16 (47.1%)	123 (40.6%)
5	9 (16.4%)	6 (17.6%)	89 (29.4%)
6	1 (1.8%)	1 (2.9%)	20 (6.6%)
7	0 (0.0%)	0 (0.0%)	6 (2.0%)
8	0 (0.0%)	0 (0.0%)	5 (1.7%)
Total	55 (100%)	34 (100%)	303 (100%)

Table 23 Total family members and vehicles distribution in Vietnam household

No. of family member	Motorcycle only	Both car and motorcycle
3	20 (4.1%)	2 (4.1%)
4	96 (19.7%)	12 (24.5%)
5	168 (34.5%)	20 (40.8%)
6	127 (26.1%)	9 (18.4%)
7	60 (12.3%)	6 (12.2%)
8	16 (3.3%)	0 (0%)
Total	487 (100%)	49 (100%)

Table 24 Total monthly household income and vehicle ownership in Taiwan household

Monthly household income(NT)	Motorcycle only	Car only	Both car and motorcycle
<20000	23 (41.8%)	8 (23.5%)	71 (23.4%)
20000-40000	27 (49.1%)	16 (47.2%)	153 (50.5%)
40000-60000	4 (7.3%)	6 (17.6%)	42 (13.9%)
60000-80000	0 (0.0%)	2 (5.9%)	21 (6.9%)
80000-100000	0 (0.0%)	1 (2.9%)	4 (1.3%)
>100000	0 (0.0%)	1 (2.9%)	5 (1.7%)
Missing	1 (1.8%)	0 (0.0%)	7 (2.3%)
total	55 (100%)	34 (100%)	303 (100%)

Table 25 Total monthly household income and vehicles ownership in Vietnam household

Monthly household income (1000 VND)	Motorcycle only	Both car and motorcycle
< 5000	162 (33.3%)	21 (42.9%)
5000-10000	143 (29.3%)	15 (30.6%)
10000-15000	103 (21.1%)	5 (10.2%)
15000-20000	49 (10%)	4 (8.1%)
20000-25000	26 (5.4%)	4 (8.2%)
> 25000	6 (1.2%)	0 (0%)
total	487 (100%)	49 (100%)

Table 26 Number of age 19-30 family member and vehicles ownership in Taiwan household

Number of age 19-30 member	Motorcycle only	Car only	Both car and motorcycle
0	13 (23.6%)	15 (44.1%)	51 (16.8%)
1	19 (34.5%)	5 (14.7%)	58 (19.1%)
2	16 (29.1%)	10 (29.4%)	121 (39.9%)
3	6 (10.9%)	4 (11.8%)	62 (22.4%)
4	0 (0.0%)	0 (0.0%)	9 (3.1%)
5	1 (1.9%)	0 (0.0%)	2 (0.7%)
Total	55 (100%)	34 (100%)	303 (100%)

Table 27 Number of age 19-30 family member and vehicles ownership in Vietnam household

Number of age 19-30 member	Motorcycle only	Both car and motorcycle
0	119 (24.4%)	12 (24.5%)
1	252 (51.7%)	30 (61.2%)
2	83 (17%)	5 (10.2%)
3	31 (6.4%)	1 (2%)
4	2 (0.4%)	1 (2%)
Total	55 (100%)	49 (100%)

Table 28 Number of age 30+ family member and vehicles ownership in Taiwan household

Number of age 30+ member	Motorcycle only	Car only	Both car and motorcycle
1	14 (25.5%)	9 (26.5%)	48 (15.8%)
2	37 (67.3%)	23 (67.6%)	232 (76.6%)
3	4 (7.2%)	2 (5.9%)	14 (4.7%)
4	0 (0.0%)	0 (0.0%)	4 (1.3%)
5	0 (0.0%)	0 (0.0%)	4 (1.3%)
6	0 (0.0%)	0 (0.0%)	1 (0.3%)
Total	55 (100%)	34 (100%)	303 (100%)

Table 29 Number of age 30+ family member and vehicles ownership in Vietnam household

Number of age 30+ member	Motorcycle only	Both car and motorcycle
1	36 (7.4%)	4 (8.2%)
2	368 (75.6%)	37 (75.5%)
3	60 (12.3%)	6 (12.2%)
4	21 (4.3%)	1 (2%)
5	2 (0.4%)	1 (2%)
Total	487 (100%)	49 (100%)

### 3. Survey Results Comparison among Taiwan, Vietnam and Malaysia

Malaysia has also performed similar vehicle ownership researches but with simplified questionnaire. For comparative analysis, the survey results of Malaysia, Taiwan and Vietnam have been collected and compared. Due to different research scope and contents, only comparable categories are extracted in the following.

#### 3.1 Vehicle Owning Analysis

In Vietnam, 98.7% respondents own only motorcycle. They have no car at the same time. The percentage of people who own both car and motorcycle in relation to the totally population consists of is about 30% both in Taiwan and in Malaysia, as shown in Table 30. From above statements, Taiwanese are presumed to select motorcycles as their first choice of transportation mode. However, Malaysians are thought to prefer cars, which are more comfortable than motorcycles for the rainy yet sweltering weather.

Table 30 Vehicle Owning

Vehicle owning	Taiwan		Malaysia		Vietnam	
	Number	(%)	Number	(%)	Number	(%)
Motorcycle only	199	50.6	135	31	529	98.7
Car only	73	18.6	171	39.3	3	0.6
Both motorcycle and car	121	30.8	129	29.7	4	0.7
Total	393	100	435	100	536	100

### 3.2. Causes of Owning Motorcycles Only

According to Taiwanese respondents who acquire only motorcycles, high mobility, ease on parking and low fuel consumption and related costs are three main reasons for choosing motorcycles. The percentages of them are 90.0%, 80.4%, and 68.3%, respectively. In Malaysia, the reasons are high mobility (60.2%), fuel costs (24.2%), and high car prices (9.8%). In Vietnam, however, fuel costs (42.1%), high car prices (39.3%), and no convenient public transportation (10.3%) are the major considerations. Therefore, high mobility with low chances of encountering congestions is the primary motive to use motorcycle as main daily mode.

Table 31 Main factor of owning a motorcycle

Order	Taiwan		Malaysia		Vietnam	
	1	Higher mobility	38.70%	Higher mobility	60.20%	Low fuel consumption costs
2	Car too expensive	20.10%	Low fuel consumption costs	24.20%	Car too expensive	39.3%
3	Ease on parking	18.60%	Car too expensive	9.80%	No convenient public transportation	10.3%

### 3.3. Causes of Owning Cars Only

In Taiwan, people who acquire cars only state that comfort (68.5%), safety (65.8%), and to pick up more than two riders (58.9%) are the main reason for using car. In Malaysia, however, humid weather (35.3%), convenience and time saving (19.3%), and for long commuting distance (14.7%) are the main considerations. Hence, the degree of comfort plays a determining role in selecting cars over motorcycles, as shown Table 32.

Table32 Main factor of owning a car (No car only sample in Vietnam)

Order	Taiwan		Malaysia	
1	Saver	(28.7%)	Hot and Rainy weather	(35.3%)
2	Constant carpooling	(17.8%)	Comfortable and save time	(19.3%)
3	Family recreational activities	(16.4%)	Long traveling distance	(14.7%)

### 3.4 Commuting Distance

Most commuting distance is less than 10 km in Malaysia, Taiwan, and Vietnam

Table 33 Commuting distance

Distance	Taiwan Car trip (%)	Malaysia Car trip (%)	Vietnam Car trip (%)	Taiwan Motorcycle Trip (%)	Malaysia Motorcycle Trip (%)	Vietnam Motorcycle Trip (%)
<10km	50.5	63	100	72.5	75.8	99.6
11-20km	24.7	18	0	22.2	17	0.4
21-30km	10.5	7	0	2.4	3.4	0
31-40km	3.8	5	0	1.7	1.5	0
41-50km	2.9	4	0	0.8	1.9	0
>50km	7.6	3	0	0.4	0.4	0
<b>Average</b>	<b>19.84</b>	<b>13.95</b>	<b>4.66</b>	<b>9.48</b>	<b>8.81</b>	<b>3.62</b>

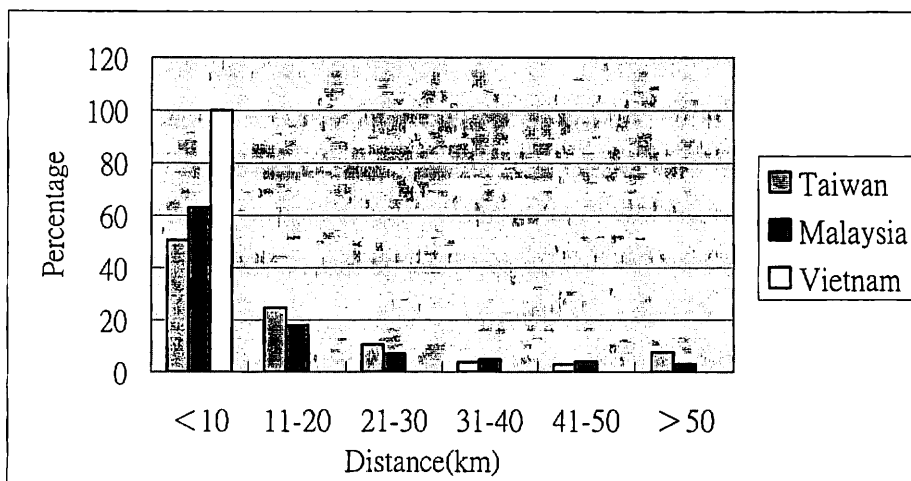


Figure 5 Commuting distance of car trip

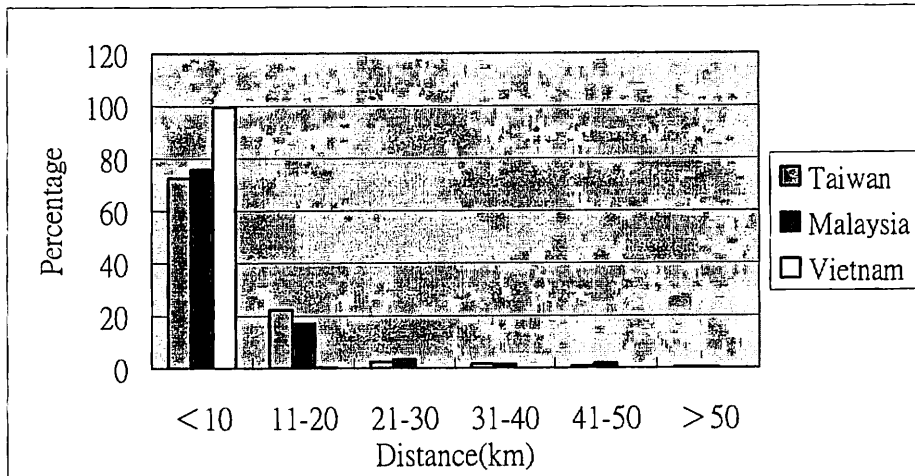


Figure 2 Commuting distance of motorcycle trip

### 3.5 Total family members in household

Most of the respondents in Malaysia and Vietnam have 4 to 6 family members residing together, and those in Taiwan have 4 to 5 members.

Table 34: Total family members in household

Number	Taiwan(%)	Malaysia(%)	Vietnam(%)
1	1.8	8	0
2	9.4	5.7	0
3	13.2	13.3	4.1
4	40.7	25.1	20.1
5	26.5	22.3	35.1
6	5.3	15.4	25.4
7	1.8	4.1	12.3
8	0.3	3.4	2.6
9	1	1.6	0.4
10	0	0.7	0
>10	0	0.2	0
<b>Average</b>	<b>4.1</b>	<b>4.43</b>	<b>5.37</b>



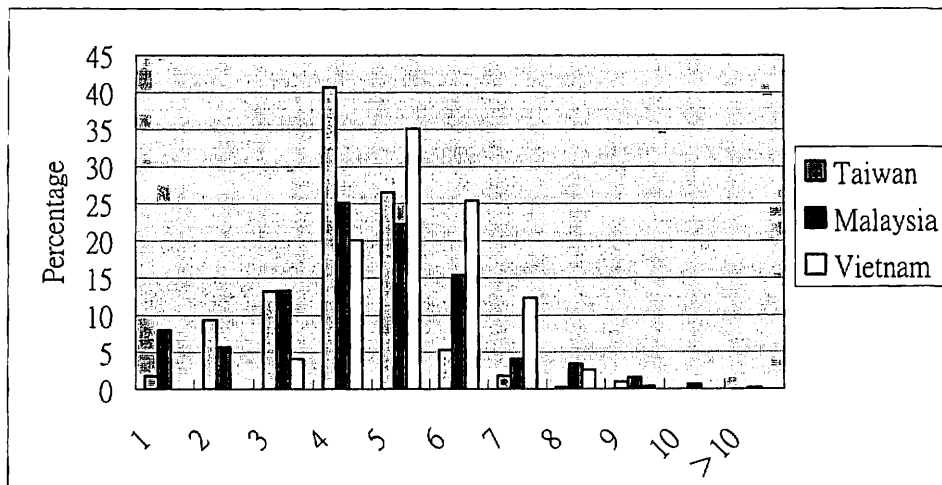


Figure 6 Total family members in household

### 3.6 Motorcycle distribution in household

Most household in Malaysia and Taiwan have 1 to 2 motorcycles, and 3 to 4 in Vietnam household.

Table 35: Motorcycle distribution in household

Motorcycles number	Taiwan(%)	Malaysia(%)	Vietnam(%)
0	8.9	18.4	0
1	32.1	43.2	1.1
2	33.3	24.1	12.3
3	20.4	9.4	31.3
4	4.1	2.8	30.6
5	0.8	0.7	19.4
>5	0.5	1.4	5.2
<b>Average</b>	<b>1.82</b>	<b>1.44</b>	<b>3.71</b>

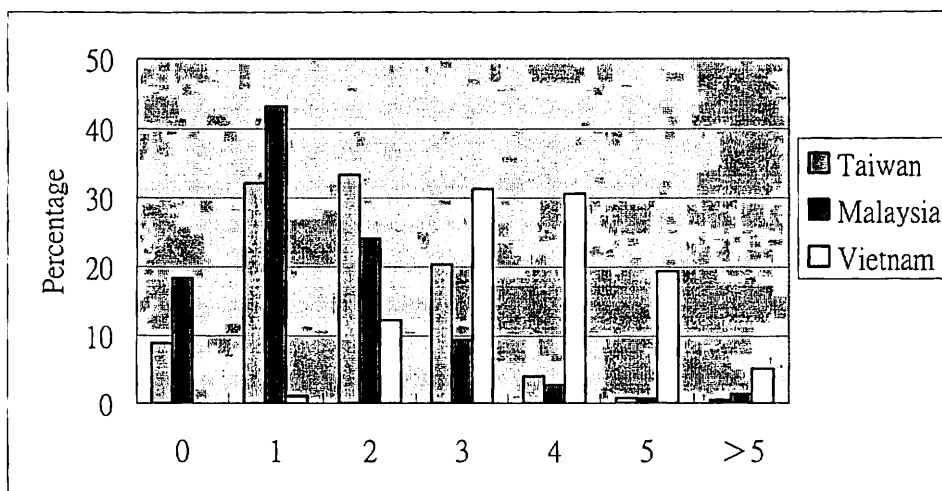


Figure 7 Motorcycle distribution in household

### 3.7 Car number in household

In Malaysia, most households have 1 to 2 cars. In Taiwan, about half households have 1 car. There were no cars in more than 90% Vietnam households.

Table 36: Car distribution in household

Cars number	Taiwan(%)	Malaysia(%)	Vietnam(%)
0	14.2	8	90.9
1	57.8	46.7	9.1
2	23.9	30.8	0
3	3.1	7.8	0
4	0.8	4.6	0
5	0.3	1.2	0
>5	0	0.9	0
<b>Average</b>	<b>1.19</b>	<b>1.62</b>	<b>0.09</b>

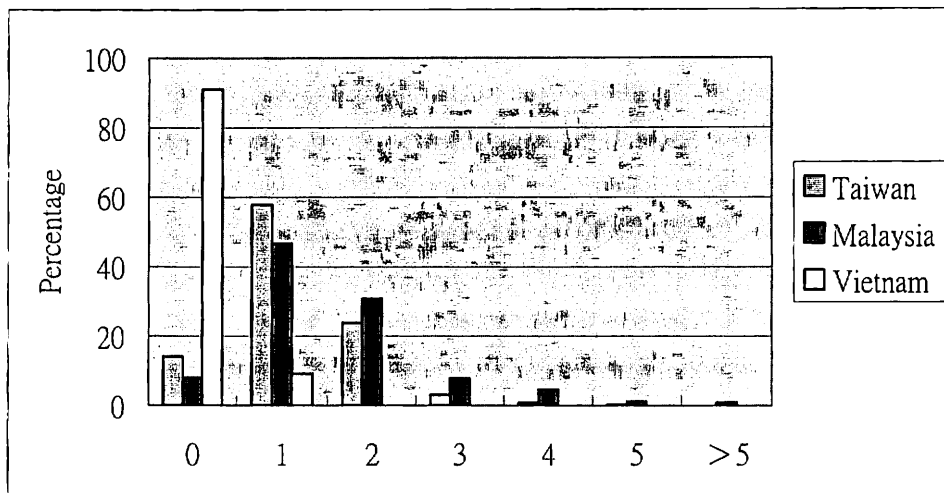


Figure 8: Car distribution in household

### 3.8 Motorcycles driving license in household

In Malaysia, most of the household have 1 to 2 family member who has a motorcycle driving license. Number of Motorcycles driving license In Taiwan household is 3 to 4, and 2 in Vietnam household.

Table 37: Motorcycles driving license in household

Number of Motorcycles driving license	Taiwan(%)	Malaysia(%)	Vietnam(%)
0	5.1	10.3	0
1	15.5	30.6	28.9
2	26	29.4	71.1
3	20.9	13.7	0
4	22.4	8.5	0
5	7.9	4.5	0
>5	2.3	3	0
<b>Average</b>	<b>2.73</b>	<b>2.01</b>	<b>1.71</b>

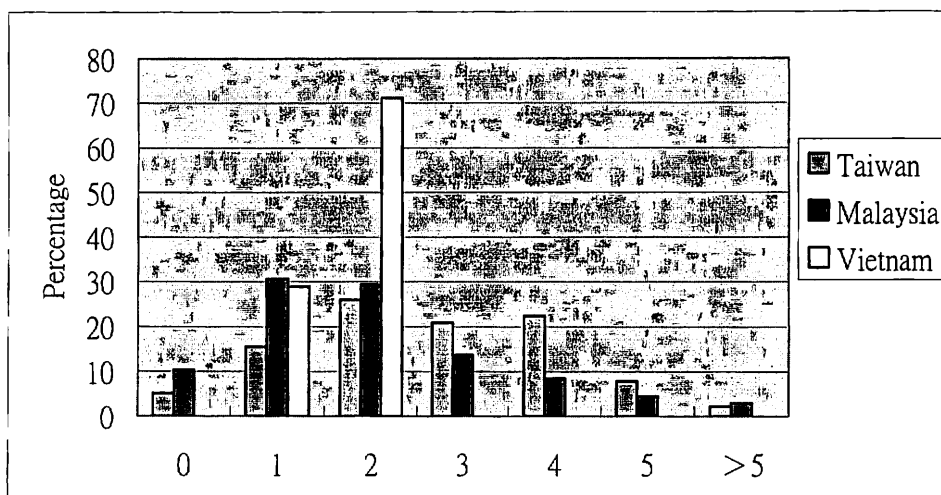


Figure 9: Motorcycles driving license in household

### 3.9 Cars driving license in household

In Malaysia and Taiwan, most of the household have 2 family members who have a motorcycle driving license, and in Vietnam, most households have none driving licenses.

Table 38: Cars driving license in household

Number of Cars driving license	Taiwan(%)	Malaysia(%)	Vietnam(%)
0	3.8	3	90.9
1	14	19.5	7.8
2	36.1	36.1	1.3
3	24.7	16.8	0
4	13.5	15.4	0
5	5.6	6.7	0
>5	2.4	2.5	0
<b>Average</b>	<b>2.66</b>	<b>2.52</b>	<b>0.1</b>

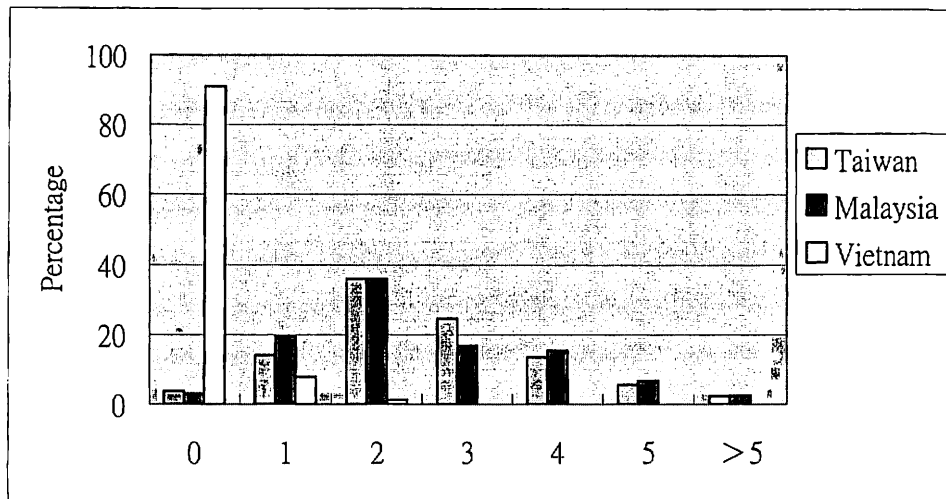


Figure 10: Cars driving license in household

#### 4. Conclusion

Taiwan, Malaysia and Vietnam have different motorcycle utility characteristics and ownership reason. However, it causes the similar dependency situation on motorcycle for getting high mobility. In Taiwan and Malaysia, there are a lot of families have the car and motorcycle at the same time. This phenomenon is the special situation in Asian countries. The substitution between car and motorcycle can be proven exist in the household choice of vehicles. However, due to the high percentage of owning both car and motorcycle, the whole number of motorcycles will not be influenced by the car growing. Because these three countries have different economic development stages, their experience in motorcycle ownership and utility will be useful for referring to the other Asian countries.

## STUDY ON THE OWNERSHIP OF MOTORCYCLES IN VIETNAM

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### ABSTRACT

*With the published macro social-economic data collected and collected data from two surveys, this paper begins with an analysis on features impacting on motorcycle ownership in Vietnam and follows with the results of statistical calculations. It seems that there is a good correlation between the total number of motorcycles as the dependent variable and other dependent variables such as the number of population, the purchasing power parity per capita, the urbanization rate etc This fact can be explained by the great demand of people on this kind of vehicle and by the high growth rate of economy in the whole. The paper includes some results in the case of car to make a comparison.*

**Keywords:** *motorcycle, ownership, statistical calculation*

### 1. INTRODUCTION

From prior years, the great growth rate of motorcycle (for short, we will denote both motorbike in the conception of motorcycle) is one of special features in transport of Vietnam . Now, this kind of vehicle becomes more and more popular by its known advantages.

In study on motorcycle ownership of this country, there are two remarkable aspects:

- There is a very great demand on motorcycle (and car) now. Not only in urban, but in rural areas, the people want to possess this vehicle so that they buy immediately right after they have enough financial condition.
- The high growth rate of the whole economy shows that in general, the income of citizens is improved day by day. This can be seen everywhere. So, more and more people have enough good income and the purchasing power is improved really.

Two these aspects lead to question on the relation between the total number of motorcycle with other social-economic indexes. This relation can be found by statistical calculations. The necessary data can be collected through:

- the macro social-economic ones from published sources such as the General Statistical Office (GSO) of Vietnam and other as Internet.
- the micro data through survey. The study team has carried out one survey by questionnaire designed by Hsu Tien-Pen in Bac Giang and in Ha Noi. One another survey with modified questionnaire has been carried out through Internet Both are fulfilled in August 2005.

In the next paragraphs, the results of statistical process will be presented. First of all, the next paragraph deals with the features that can impact on the motorcycle ownership such as policies of the Authorities, income of individual/household etc. After that, in the paragraph 3, the results of statistical calculation shows that there is a very good correlation between the total number of motorcycle and other social-economic variables The next paragraph shows some similar calculation in the case of car to make a comparison between two kind of vehicles.

## **2. FEATURES ON MOTORCYCLE OWNERSHIP OF INDIVIDUAL/HOUSEHOLD**

In this paragraph, we will consider special factors that can impact to the ownership of individual or household. The data are collected from two sources:

- Census made by the General Statistical Office in rural, agricultural and fishery areas 2001
- Two mentioned surveys.

### **2.1. Great demand on motorcycles**

For various known advantages of motorcycles, this kind of vehicle is employed more and more popular in the country. In comparison with other countries, together with the function as a transport mean of each individual, motorcycles in Vietnam can be used in:

- An instrument to earn: in numerous familiars, motorcycles is an main instrument in their daily works to bring products everywhere
- A professional instrument: it is “xe om” (transferring vehicle), motorcycle drivers contribute to the transport by carrying along with them goods/passengers from everywhere to everywhere. It can be seen not only in cities, but at every villages, every rural areas. This “xe om” is familiar for they can run on the ways that car can not, or on the way that traffic flow is so low that car became ineffective. In the prior years, there was another kind, the “xe loi” (pulling vehicle) but now the local governments in various areas have prohibited it for the very low traffic safety.
- Hobby instrument

**Table 1: Most Common Durable Assets of Households**

No	Durable asset	In rural, agricultural and fishery area (*)		In urban (**)	
		Percentage of households having this asset	Average number of this asset in 100 households	Percentage of households having this asset	Average number of this asset in 100 households
1	Wooden interior house ware (cupboard, bed, wardrobe, table and chairs etc)	76.22	151.8	99.56	454.6
2	Television set	54.91	55.3	90.67	102.3
3	Motorcycle	25.92	28.9	93.95	133.6
4	Water pump	24.32	25.1	76.72	78.93

Source:

(\*) Data from survey of 145,871 households, see GSO 2003

(\*\*) Data from Internet Survey

It is the high multi-usages of motorcycles that lead to a very high demand on motorcycles. The various surveys on durable assets of households show that, together with wooden interior house ware (cupboard, wardrobe, bed, table and chairs) and television set, motorcycle is one of the first three popular durable assets of each family. See Table 1 on “Durable assets of households”

## 2.2. Features on the motorcycle ownership of individual/household

These features can be divided into three groups:

- Policies of the Central Government and local governments
- Income of individual/household
- Various expenditures needed for a motorcycle
- Others

### 2.2.1 Policies of the Central Government and local governments

It is remarkable that these policies have the aim, to reduce the highly increasing numbers of running motorcycles: by limitation in quota to import motorcycles and spare parts, by high rate of tax and relative fees of all kinds, by encouraging public transport etc in central level. The local government of Ha Noi has decided that the motorcycles of people living in urban districts now cannot be registered, that means the vehicles that have been registered before a deadline can run. Both Ha Noi and Ho Chi Minh city carry out subsidy policy for public transport.

What is the result of these policies? From public media and collected data and from the real life, the number of motorcycles is still increasing and the people still buy more and more this vehicle. The Internet Survey shows that in urban a percentage of 94.65 % and in other area 54.76 % people said that they would keep the existing motorcycle or buy new one in spite of the said policies.

### 2.2.2 Income of individual/household

It is remarkable that there are numerous problems now in the salary policies of Vietnam so that the National Assembly has several times opinions. By these problems it is very difficult to know exactly the income of each individual or household by questionnaire only. In answer, the interviewee says the routine income only that is usually very low while they can have other income infrequent. For example, for the price of land is increasing dramatically, the peasants in various agricultural areas can sell a part of their use-right on their land and receive in many cases a very large amount. After that a major of them spend this amount for two things: house and motorcycle.

While the correct income of each individual/household cannot be known exactly, it can say that this income is increasing in general so that the people can buy more and more motorcycles. A majority of 87.49 % of people in urban and a percentage of 42.14 % in other area said through the Internet Survey that their real income is still enough for having a motorcycle.

### 2.2.3 Expenditures for motorcycle

There are following expenditures:

- Purchase cost,
- Registration and Insurance fee,
- Fuel cost,
- Maintenance and operation costs (parking, cleaning etc)

**Purchase cost:** With the Questionnaire Survey, in Bac Giang area the cost is about 7.000.000 up to 15.000.000 VND (443 – 993 USD) while in Hanoi, the number is about 12.000.000 to 50.000.000 VND (750-3,164 USD). The Internet Survey gives similar results. The purchase cost varies in a very large scale for there are numerous kinds in the market, both new or second hand, so that the people can easily choose that is suitable with his/her pocket.

**Registration fee and Insurance fee:** Nobody complains this fee in spite of the fact this fee has been several increased.

**Fuel cost:** This cost includes all kinds of tax and other fee as defined by the Government and has been increased several times, especially from the last year (see Table 2).

**Table 2: The Variation of Fuel Prices**

Unit: VND/ liter

	Gasoline 92	Gasoline 90	Gasoline 83	Diesel	Kerosene
Begin of 1997			4,300	3,700	
End of 1997			4,300	3,500	
February 1998			4,200	3,500	
...					
February 22, 2004	6,000	5,800		4,600	3,400
June 19, 2004	7,000	6,800		4,800	3,570
November 01, 2004	7,500	7,300		4,850	4,800
March 29, 2005	8,000	7,800		5,500	4,900
July 03, 2005	8,800	8,600	8,400	6,500	6,500
August 17, 2005	10,000	9,800	9,600	7,500	7,500

Source: The study team



The last modification of fuel prices is after all surveys. So, both surveys deal with the prices of July 03, 2005.

In the Questionnaire Survey, a majority shows that the fuel cost is less than 200.000 VND (12.66 USD) per month. The Internet Survey shows that 71.67 % spend for the fuel cost up to 100.000 VND (6.33 USD) per month while 12.35 % spend from 100.000 up to 150.000 VND (6.33 – 9.50 USD) and 10.34 % spend from 150.000 up to 200.000 VND (9.50-12.66 VND) and 5.64 % spend more than 200.000 VND (12.66 USD) per month for fuel. It seems that the fuel cost is acceptable for all interviewees without any complain.

### **Maintenance and operation costs**

In the Questionnaire Survey, a majority shows that these costs are less than 500.000 VND (31.65 USD) per year. The Internet Survey shows similar result with 92.34 %. It seems that the people can bear these costs.

## **3. REGRESSION MODEL**

This paragraph deals with the statistical processing collected data to find out the correlation between the social-economic variables and the number of motorcycles, that evidently is the dependent variable. The whole data to be used is in the appendix and contains those from 1991 to 2004 (the data of prior years are not available unfortunately). The software is Excel 2000.

### **3.1. Independent Variables on Population and on Urbanization rate**

The social-economic parameters that can impact on the dependent variable (we denotes by symbol *mcy* the total number of registered motorcycles) obviously are:

- Population,
- Urbanization rate,
- Financial aspect of motorcycle users.

**Population (pop):** As above mentioned, a majority of adult people want to possess for him/herself this kind of vehicle. That is why the number of population (denotes by *pop*) will have close relation with the *mcy* variable. In fact, from Table 3, it is remarkable the correlation between *mcy* and *pop* follows the regression equation:

$$mcy = -63326908.22 + 0.610250652 \times pop \quad (1)$$

Where: *mcy*: Total number of motorcycle

*pop*: Total population

The high values of correlation coefficient *R* (all multiple, *R*<sup>2</sup> and adjusted *R*<sup>2</sup>) shows that this correlation is very good. Similarly, the very low value of Sig-F (1.90098E-07) denotes that the *H*<sub>0</sub>-hypothesis seems ignorable.

**Table 3: Results of Regression Calculation with Population Variable**

Regression Statistics	
Multiple R	0.950531458
R Square	0.903510053
Adjusted R Square	0.895469224
Standard Error	1238514.383
Observations	14

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	1.72359E+14	1.72359E+14	112.365287	1.90098E-07
Residual	12	1.8407E+13	1.53392E+12		
Total	13	1.90766E+14			

	Coefficients	Standard Error	t Stat	P-value
Intercept	-51499512.07	5428367.313	-9.487108941	6.30648E-07
X Variable 1	0.768136057	0.072463961	10.60024938	1.90098E-07

	Lower 95.0 %	Upper 95.0 %
Intercept	-63326908.22	-39672115.93
X Variable 1	0.610250652	0.926021462

**Urbanization rate (urb):** This rate indicate the number of people in urban in comparison with the total population.. It is easily to predict the correlation between mcy and urb. The Table 4 gives following regression equation:

$$mcy = -29086468.99 + 1545052.574 \times urb \quad (2).$$

Where:            mcy: Total number of motorcycle  
                       urb: Urbanization rate

Similarly to the above case, the high values of correlation coefficient R shows that this correlation is very good and the very low value of Sig-F denotes that the H0-hypothesis seems ignorable.

**Table 4: Results of Regression Calculation with Urbanization Rate Variable**

Regression Statistics	
Multiple R	0.949685441
R Square	0.901902437
Adjusted R Square	0.89372764
Standard Error	1248789.187
Observations	14

ANOVA					
	df	SS	MS	F	Significance F

Regression	1	1.72052E+14	1.72052E+14	110.3271974	2.10069E-07
Residual	12	1.87137E+13	1.55947E+12		
Total	13	1.90766E+14			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	-29086468.99	3350916.939	-8.680152184	1.61524E-06
X Variable 1	1545052.574	147096.3745	10.50367543	2.10069E-07

	<i>Lower 95.0 %</i>	<i>Upper 95.0 %</i>
Intercept	-36387489.68	-21785448.3
X Variable 1	1224557.112	1865548.037

### 3.2. On the independent variable on financial aspect

As above mentioned, it is difficult to have information on income of people through questionnaire. Instead of this, there are several economical indexes that can be useful. They are:

- GDP (Gross Domestic Product) per capita, symbolized by *gdp*
- PPP (Purchasing Power Parity) per capita, symbolized by *ppp*, and
- FC (Final Consumption) per household, symbolized by *fch*.

These indexes are obviously not quite independent and all of them express the income of people in general. The calculations with linear regression between the dependent variable M with each of these variables extra have results as shown in the Table 5.

**Table 5: Linear Regression between *mcy* and Each of Economic Variables**

<i>mcy</i> in statistical relation with (extra)	Number of Observations	Multiple R	Significance F
<i>gdp</i> : GDP per capita	13	0.966448408449129	7.77232618331495E-08
<i>ppp</i> : PPP per capita	14	0.991600630568285	4.97900385345092E-12
<i>fch</i> : FC per household	10	0.993487612037297	7.80802339700116E-09

With very good value of R and very low value of Sig-F, this Table shows that each of these variables can be used in the regression calculation with the dependent variable M. In conception, the Final Consumption per household express the capability of household to buy goods. It would be the best to use in this study but unfortunately the data is very limited (up to 2000 only). Among GDP and PPP per capita, the last is better both in the meaning of concept and in the regression values. That is why in this study, we choose value PPP per capita (*ppp*) as the variable expressing the financial aspect of people.

### 3.3. Multiple Regression

The Table 6 presents all results to calculate the multiple regression between M with three independent variables. From this, the total number of motorcycles can be expressed by following linear equation:

$$mcy = -7192516.765 + 0.020804096 \times pop + 6447.490353 \times ppp + 8110.564977 \times urb \quad (3).$$

Where: *mcy*: Total number of motorcycle

pop: Total population  
 ppp: Purchasing Power Parity per capita  
 urb: Urbanization rate

Once again similarly to the above cases, the high values of correlation coefficient R shows that this multiple correlation is very good and the very low value of Sig-F denotes that the H0-hypothesis seems ignorable.

**Table 6: Multiple Regression Calculation on the Total Number of Motorcycles**  
 SUMMARY OUTPUT

<i>Regression Statistics</i>					
Multiple R		0.991640127			
R Square		0.983350141			
Adjusted R Square		0.978355183			
Standard Error		563580.4608			
Observations		14			

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	1.8759E+14	6.253E+13	196.8685573	3.43963E-09
Residual	10	3.17623E+12	3.17623E+11		
Total	13	1.90766E+14			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	-7192516.765	8206271.769	-0.876465826	0.401341054
X Variable 1	0.020804096	0.218554802	0.095189381	0.926044868
X Variable 2	6447.490353	960.5771881	6.712100217	5.28456E-05
X Variable 3	8110.564977	437036.2791	0.018558105	0.985558684

	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	-25477232.89	11092199.36
X Variable 1	-0.466166434	0.507774627
X Variable 2	4307.190629	8587.790076
X Variable 3	-965667.1166	981888.2466

### 3.4. Correlations on Industrial Structure shared on GDP

The Table 7 gives the results of linear regression with Industrial Structure shared on GDP as independent variable:

gdp1: Industrial Structure shared on GDP: Sector 1 (Agriculture, Forestry and Fisheries) gdp2: Industrial Structure shared on GDP: Sector 2 (Industry and Construction)  
 gdp3: Industrial Structure shared on GDP: Sector 3 (Service)

**Table 7: Linear Regression between *mcy* and Industrial Structure shared on GDP**

<i>mcy</i> in statistical relation with (extra)	Number of Observations	Multiple R	Significance F
gdp1	12	0.770086571473472	0.00338830403647802
gdp2	12	0.934982166792222	8.19898825821607E-06
gdp3	12	0.341686500917183	0.277019332656982

It seems that the correlation in the case of gdp2 is good with  $R=0,935$  and Sig-F very small. The case gdp1 is acceptable. It is different with two these variables, the case of gdp3 with  $R = 0,342$  and the high value of  $\text{Sig-F}=0,277$  shows that there is a bad correlation and the  $H_0$ -hypothesis on the lack of statistical relation between *mcy* and gdp3 is acceptable.

#### 4. ON CAR OWNERSHIP

Similar calculations with the total number of registered car, denoted by *car* as dependent variable give some results as presented in the Table 8.

It is quite similarly to the case of motorcycle, the correlations seem good with high value of R and low value of Sig-F.

The correlation between the total number of car and the total number of motorcycle as shown in this Table can be explained by the fact that both kinds of vehicle are now in great demand in Vietnam and the living conditions of people are being improved.

**Table 8: Regression with the Dependent Variable *car***

<i>car</i> in statistical relation with independent variable	Number of Observations	Multiple R	Significance F
pop (extra)	14	0.96484277399183	2.52716405586398E-08
ppp (extra)	14	0.99537285312288	1.40301277199589E-13
urb (extra)	14	0.96487589221319	2.51309490463651E-08
<i>mcy</i> (extra)	14	0.99492346428469	2.44437354500099E-13
gdp (extra)	13	0.98509372743956	9.29439258032581E-10
pop, ppp and urb	14	0.99653437528220	4.28084139982645E-11

#### 5. CONCLUSION

It is different to the cases of several other countries, this study shoed that in Vietnam, there are a good correlations between the total number of motorcycles with other social-economic variables. There are two reasons. Firstly, now motorcycles in Vietnam is situated in the first phase of the Supply-Demand curve, that means a great demand on this vehicle. Secondly, the living standards of people is being improved.

The paper opens several directions for next studies, such as: a more detail comparison between motorcycle and car ownership; prediction of growth number of this vehicle in the coming years etc.

## **ACKNOWLEDGEMENT**

The authors want to express their warm thanks to EASTS and ICRA group for financial support and cooperation. Special thanks are dedicated to TSSV colleagues for various support in collection of data, in survey etc.

## **ABBREVIATION:**

GSO	General Statistical Office of Vietnam
mcy	Variable: total number of registered motorcycles
car	Variable: total number of registered cars
pop	Variable: population number
GDP	Gross Domestic Product
gdp	Variable: GDP per capita
PPP	Purchasing Power Parity
ppp	Variable: PPP per capita
urb	Variable: urbanization rate
FC	Final consumption
fch	Variable: FC per household

## **REFERENCE**

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**APPENDIX (extracted)**

**Appendix 1. Statistical data of Vietnam**

*Source: GSO 2005 and other data from GSO*

Year	Total number of registered motorcycles	Total number of registered cars	Population	PPP (USD) per capita	Urbanization rate	GDP (USD) per capita	Final consumption (USD) per household
1991	1,522,184	256,898	67,242,400	1,080	19.67	188	950
1992	1,704,225	270,036	68,450,100	1,154	19.85	201	1,281
1993	2,427,163	292,899	69,644,500	1,226	20.05	213	1,528
1994	3,052,847	307,708	70,824,500	1,312	20.37	228	1,882
1995	3,578,156	340,799	71,995,500	1,413	20.75	246	2,346
1996	4,208,247	386,976	73,156,400	1,521	21.08	265	2,768
1997	4,827,218	417,768	74,306,400	1,619	22.66	282	3,029
1998	5,200,000	443,000	75,456,300	1,687	23.15	293	3,392
1999	5,600,000	456,000	76,596,700	1,741	23.61	303	3,564
2000	6,478,000	486,000	77,785,500	1,950	24.18	319	3,810
2001	8,395,835	532,681	78,685,800	2,100	24.74	336	
2002	10,988,543	632,825	79,727,400	2,300	25.11	356	
2003	11,379,000	675,000	80,902,400	2,626	25.80	376	
2004	13,735,000	774,000	82,032,300	3,000	26.32		

Year	GDP share of sector 1 (%)	GDP share of sector 2 (%)	GDP share of sector 3 (%)
1991	40.5	23.5	36.0
1992	34.9	23.7	41.4
1993	29.1	28.6	42.3
1994	27.4	28.9	43.7
1995	27.2	28.8	44.1
1996	27.8	29.7	42.5
1997	25.8	32.1	42.2
1998	25.8	32.5	41.7
1999	25.4	34.5	40.1
2000	24.5	36.7	38.7
2001	23.2	38.1	38.6
2002	23.0	38.5	38.5

## Appendix 2. Results of both Surveys Distributed by Age Groups

Total number of collected sheets                    537  
 Total number of useful sheets                        536

Age groups	12-18	19-30	31-40	41-50	51-60	> 60
Total number	12	125	142	134	96	27
1. 1. How many motorcycles owned by interviewees: (single answer)						
0	0	0	0	0	0	16
1	0	124	142	133	93	11
2	0	1	0	1	3	0
> 2	0	0	0	0	0	0
1. 2. How many cars owned by interviewees: (single answer)						
0	0	124	141	131	89	25
1	0	1	1	4	7	2
> 1	0	0	0	0	0	0
6.2. Purchase cost of the first vehicle as motorcycle						
< 7 Mil. VND	0	26	29	17	12	0
From 7 to under 10 Mil. VND	0	45	53	59	26	2
From 10 to under 15 Mil. VND	0	52	58	46	43	8
From 15 to under 30 Mil. VND	0	2	1	10	13	1
From 30 to under 50 Mil. VND	0	0	1	2	2	0
> 50 Mil. VND	0	0	0	0	0	0
7. Principal transportation mode for daily travel						
Car	0	1	1	2	4	1
Motorcycle/Scooter	0	124	132	124	75	11
Bicycle	8	0	0	1	2	8
Bus	2	0	9	7	11	0
By foot	2	0	0	0	4	7



<i>Other</i>	0	0	0	0	0	0
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## MODELLING MOTORCYCLE OWNERSHIP IN MALAYSIA

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### ABSTRACT

High composition of motorcycles in a mixed traffic situation is common in most Asian countries. In Malaysia, there are approximately 5.8 million motorcycles on the roads and on the same note, accidents rate involving motorcycles are almost half of the total road facilities recorded. However, regardless of the high accident rate involving motorcycles, motorcycle ownership in Malaysia has increased from 0.13 in year 1990 to 0.24 motorcycles per person in year 2002. Therefore, the fast growing rate of motorcycle ownership in Malaysia has become a critical issue especially with regards to safety and the management of traffic system in Malaysia. Hence, in this research, issues concerning motorcycle ownership will be investigated. A general survey was conducted to determine the significant factors influencing the ownership of motorcycles. Once the factors are identified, a disaggregate choice model describing motorcycle ownership will be derived by means of statistical analysis. Development of this model will give an indication on the expected trend of motorcycle ownership. Thus, future development of traffic system, upon taking into the consideration the role of motorcycle could be properly planned.

### 1. INTRODUCTION

Motorcycle is one of the major transportation modes in Malaysia. In Malaysia, the common type of motorcycles found on the road is that of small size motorcycles that is in the range of 70 cc to 115 cc. It is estimated that approximately 85% of all motorcycles in Malaysia are under 115 cc. Due to its small size, the mobility of motorcycles on the road is high. During traffic congestion, motorcycles often weave in and out between queuing vehicles to get to the front. Hence, traffic becomes more hazardous due to the interruption caused by motorcycles. And according to Hsu et al (2003), in developing countries where the motorcycles volume is high, the hazardous situation caused by motorcycles under mixed traffic flow is much more significant. This has been proven by the accident data in Malaysia where motorcycle fatalities are approximately 45% of the total road facilities recorded in year 2000 (Radin et al, 2004 and Harnen, 2003).

However, regardless of the high accident rate involving motorcycles, motorcycle ownership for Malaysia continue to grow from 0.13 in year 1990 to 0.24 motorcycles per person in year 2002. In terms of vehicles composition, the percentage of motorcycles registered annually in Malaysia is about 50% - 60%, that is

approximately 5.8 million motorcycles, with an average annual growth rate of approximately 7% (Highway Planning Unit, Ministry of Works Malaysia, 2003). Therefore, the fast growing rate of motorcycle ownership and its subsequent usage in Malaysia has become a critical issue in the safety and management of traffic system in Malaysia.

Currently, there have been many researches conducted around the world on car ownership such as the studies conducted by Button et al (2003) on the factors influencing the ownership of vehicles in low income countries, Dargay (2002) on the factors determining car ownership for households living in rural and urban areas, Medlock and Soligo (2002) on developing a model that predicts the relationship between economic development and the per capita rate of private ownership of cars. Dissanayake and Morikawa (2002) also have conducted a study on household travel behavior variations relating to vehicle ownership particular car and motorcycle ownership, mode choice and trip-chaining considerations by using Bangkok metropolitan region as a case study. However, not much research has been conducted to investigate the characteristics of motorcycle ownership particularly in Malaysia. Hence, in this research, a disaggregate choice model describing motorcycle ownership will be developed. Development of this model will give an indication on the future trend of motorcycle ownership in Malaysia.

## **2. MOTORCYCLE MARKET IN MALAYSIA**

### **2.1 Motorcycle ownership in Malaysia**

In Malaysia, the composition of vehicles registered annually consists mainly of passenger cars, motorcycles, buses, medium and heavy lorries with almost 50% of registered vehicles are motorcycles. The estimated number of motorcycles on the road in year 2002 was approximately 5.8 million, compared to 5 million passenger cars (Highway Planning Unit, Ministry of Works Malaysia, 2003). Motorcycle ownership in Malaysia has also increased rapidly from 0.13 motorcycles per person in year 1990 to 0.23 motorcycles per person in year 2001. Conventionally, Malaysians prefer to purchase smaller motorcycles in the range of 70 cc to 115 cc. Large motorcycles are available but not very practical because during traffic congestion there is simply not enough space for large motorcycles to weave in and out of queuing vehicles to get to the front. Majority of motorcycle owners do not own a car and belong to the lower and middle-income group. Figure 1 shows the traffic composition in Malaysia from year 1963 to year 2002. However, for other types of motorized vehicles such as lorries, trailers and buses, the data available are only for year 1987 to year 2002.

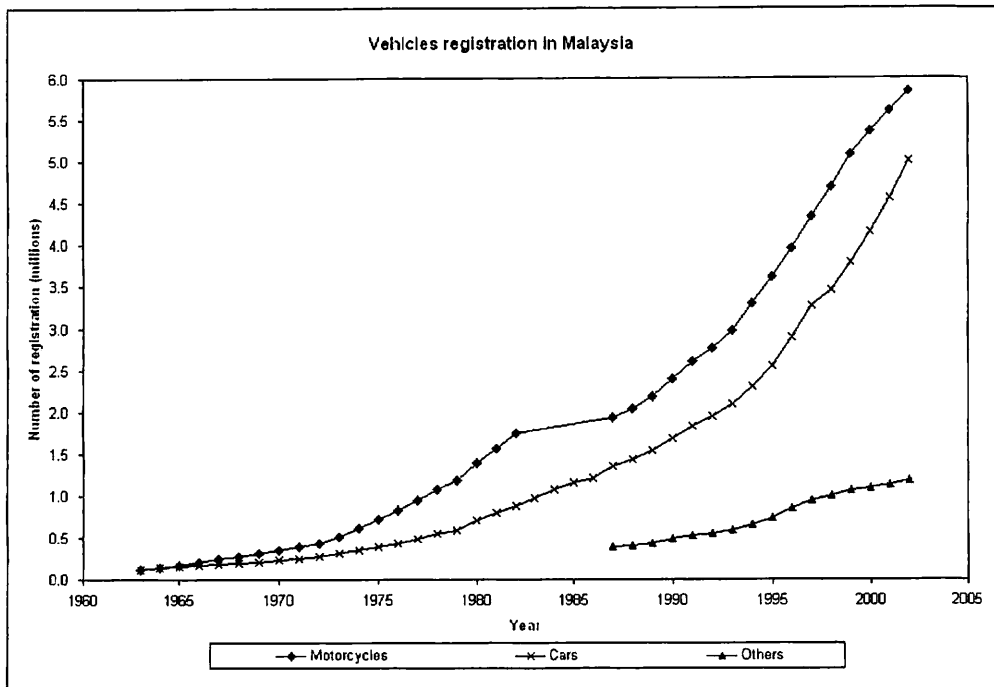


Figure 1: Ownership levels in Malaysia

Initially, an attempt was made to develop an aggregate model of motorcycle ownership based on time series data such as vehicles registration data, population data and Gross Domestic Product (GDP). Two of the best models developed were power model and multiple linear regression models as shown in Figure 2. However, there were some uncertainties in the motorcycle ownership trend that cannot be explained by both the models especially in the period of 1979 to 1987 and from 1991 to 2002 for the power model. Nevertheless, from the two models, the multiple linear regression model yields better results. This paper will illustrate the attempts made to come up with disaggregate ownership models.

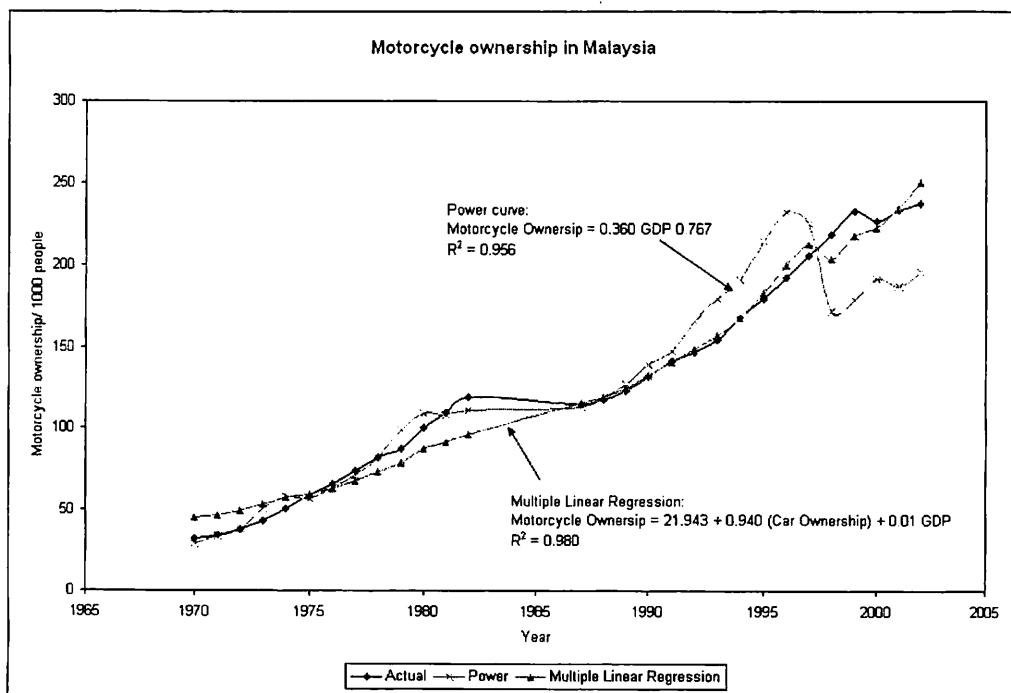


Figure 2: Aggregate motorcycle ownership forecast models

## **2.2 Factors affecting motorcycles demand in Malaysia**

It is anticipated that the motorcycles market in Malaysia will sustain and continue to grow in the future due to several factors. One of the main contributing factors is traffic congestion. As a result of the increasing number of vehicles on the road every year, traffic congestion has reached a critical level especially in the city center. Hence, motorcycles are a useful mode of transportation for commuting within the city area especially during traffic congestion due to its small size and high maneuverability. Furthermore, many roads in Malaysia are very narrow due to space constraint especially in states such as Penang and as well as in rural areas, where the roads are small and less developed. Therefore, motorcycles are the preferred mode of transportation in those situations. Apart from that, the lower income group still depends heavily on motorcycles for transportation to save cost. Parking rates for motorcycles in most of the buildings within the city areas are usually cheaper and sometimes free of charge as compared to parking rates for cars. Besides that, parking spaces for motorcycles are a lot easier to find as compared to cars. Inefficient public transportation also prompted higher motorcycles demand among the lower income group.

## **3. DATA CHARACTERISTICS**

### **3.1 Survey**

The data used in this research were collected from the interview survey conducted in the state of Penang from October 2004 to July 2005. The survey consists of just one page of questions, divided into two sections. In the first section, personal background data such as gender, race, age, marital status, monthly income, motorcycle and car ownership data, commuting purpose, destination and distance traveled using either a car or motorcycle or both were asked. Apart from that, monthly expenses on transportation as well as major factors influencing the decision to purchase either a car or motorcycle or both were asked. In the subsequent section, household information was collected. In this section, the household data such as number of family members that reside together, total household monthly income, total number of cars owned, total number of motorcycles owned and number of family members having car and motorcycle driving license were required. Details of the questionnaire are as shown in Appendix A.

### **3.2 Characteristics of survey data**

In the survey conducted, data from a total of 547 respondents were collected. Upon discarding the uncompleted surveys as well as surveys with too much misleading data or data with errors, 435 surveys were retained for an overall response rate of 79.5%. Table 1 shows the number and percentage of three motorcycle ownership levels stratified by gender, race and marital status. Based on Table 1, the results showed that majority of motorcycles owners are Malay male while marital status does not have a significant impact on motorcycles ownership.

Table 1: Number and percentage of three motorcycle ownership levels stratified by gender, race and marital status

	Gender				Race						Marital Status					
	Male	%	Female	%	Malay	%	Chinese	%	Indian	%	Other	%	Single	%	Married	%
0 motorcycle	67	25.97%	104	58.76%	102	33.89%	53	57.61%	14	35.90%	2	66.67%	84	39.07%	87	39.55%
1 motorcycle	173	67.05%	65	36.72%	179	59.47%	35	38.04%	23	58.97%	1	33.33%	123	57.21%	115	52.27%
2 plus motorcycles	18	6.98%	8	4.52%	20	6.64%	4	4.35%	2	5.13%	0	0.00%	8	3.72%	18	8.18%
Total	258	100.00%	177	100.00%	301	100.00%	92	100.00%	39	100.00%	3	100.00%	215	100.00%	220	100.00%

Table 2 and Table 3 show the number and percentage of three motorcycle ownership levels stratified by age and monthly personal income respectively. Based on Table 2 and Table 3, majority of motorcycles owners are in the range of 20 to 29 years old with a monthly income of less than RM 1000.

Table 2: Number and percentage of three motorcycle ownership levels stratified by age

	Age											
	Under 20	%	20 - 29	%	30 - 39	%	40 - 49	%	50 - 59	%	60 and above	%
0 motorcycle	1	10.00%	96	43.64%	40	39.22%	25	36.76%	8	25.00%	1	33.33%
1 motorcycle	9	90.00%	113	51.36%	55	53.92%	39	57.35%	20	62.50%	2	66.67%
2 plus motorcycles	0	0.00%	11	5.00%	7	6.86%	4	5.88%	4	12.50%	0	0.00%
Total	10	100.00%	220	100.00%	102	100.00%	68	100.00%	32	100.00%	3	100.00%

Table 3: Number and percentage of three motorcycle ownership levels stratified by personal monthly income

	Monthly Income									
	< RM 1000	%	RM 1001 - RM 1500	%	RM 1501 - RM 2500	%	RM 2501 - RM 5000	%	> RM 5001	%
0 motorcycle	31	24.60%	59	45.38%	52	44.44%	22	44.90%	7	53.85%
1 motorcycle	89	70.63%	65	50.00%	56	47.86%	23	46.94%	5	38.46%
2 plus motorcycles	6	4.76%	6	4.62%	9	7.69%	4	8.16%	1	7.69%
Total	126	100.00%	130	100.00%	117	100.00%	49	100.00%	13	100.00%

From the questionnaire survey conducted, based on a total of 435 respondents, 264 of the respondents owned at least 1 motorcycle. The main factor that influences motorcycle ownership is that motorcycles are more convenient and save time especially during traffic jams. Figure 3 shows other factors that influences motorcycles ownership.

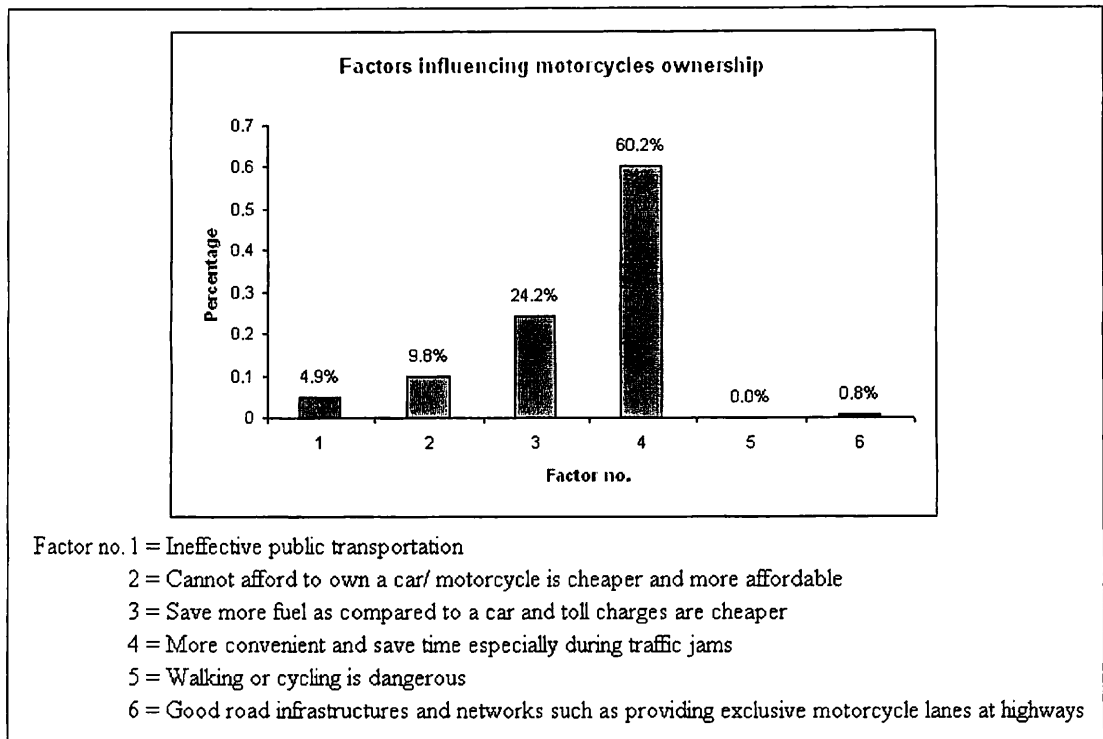


Figure 3: Factors influencing motorcycles ownership

Table 4 shows the number and percentage of three motorcycle ownership levels stratified by three levels of car ownership. From the survey conducted, as many as 394 respondents (90.6%) have car driving license and 337 respondents (77.5%) have motorcycle driving license.

Table 4: Number and percentage of three motorcycle ownership levels stratified by the number of cars owned individually

	Car Ownership					
	0 car		1 car		2 plus car	
		%		%		%
0 motorcycle	37	27.41%	118	45.04%	16	42.11%
1 motorcycle	95	70.37%	130	49.62%	13	34.21%
2 plus motorcycles	3	2.22%	14	5.34%	9	23.68%
Total	135	100.00%	262	100.00%	38	100.00%

From the questionnaire survey conducted, based on a total of 435 respondents, 300 of the respondents owned at least 1 car. According to the surveys, the main factor that influences car ownership is due to the hot and rainy weather in Malaysia. Figure 4 shows other factors that influences cars ownership.

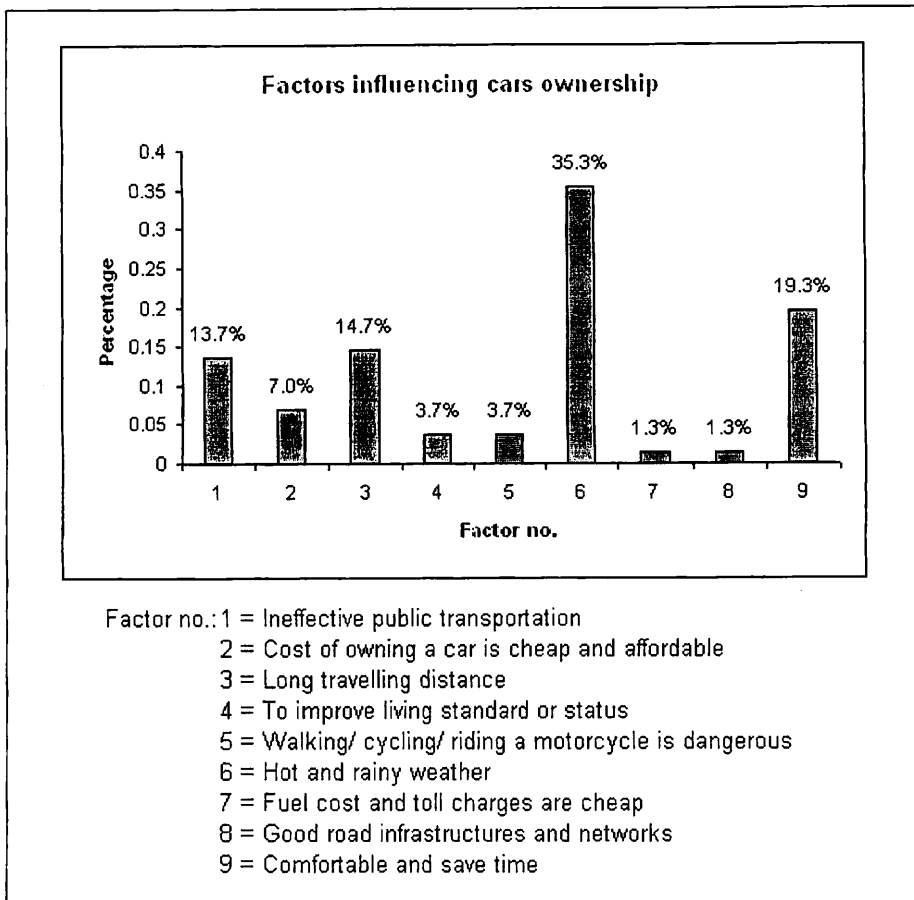


Figure 4: Factors influencing motorcycles ownership

Based on the survey conducted, generally Malaysians prefer to purchase a car once they have enough income and will keep the motorcycle purchased earlier as a secondary mode of transportation. Based on the questionnaire survey conducted, from 264 respondents that owned at least 1 motorcycle, 90.9% of them responded that they will not sell their motorcycles even if they want to purchase a new car. From the 171 respondents that do not own any motorcycles, only 29.9% of them will consider to purchase a motorcycle in the future and the reasons given are convenient, cheap, save money, save time especially during traffic jam whereas 70.8% of them responded that they will never consider purchasing a motorcycle in the future. The main reasons given for not purchasing any motorcycles are not interested particularly for those with high income who already owned a car, which constitute about 82.6%, motorcycles are dangerous, do not have a motorcycle driving license and lastly, due to low income. Figure 5 shows the relationship between motorcycles and cars ownership with income.



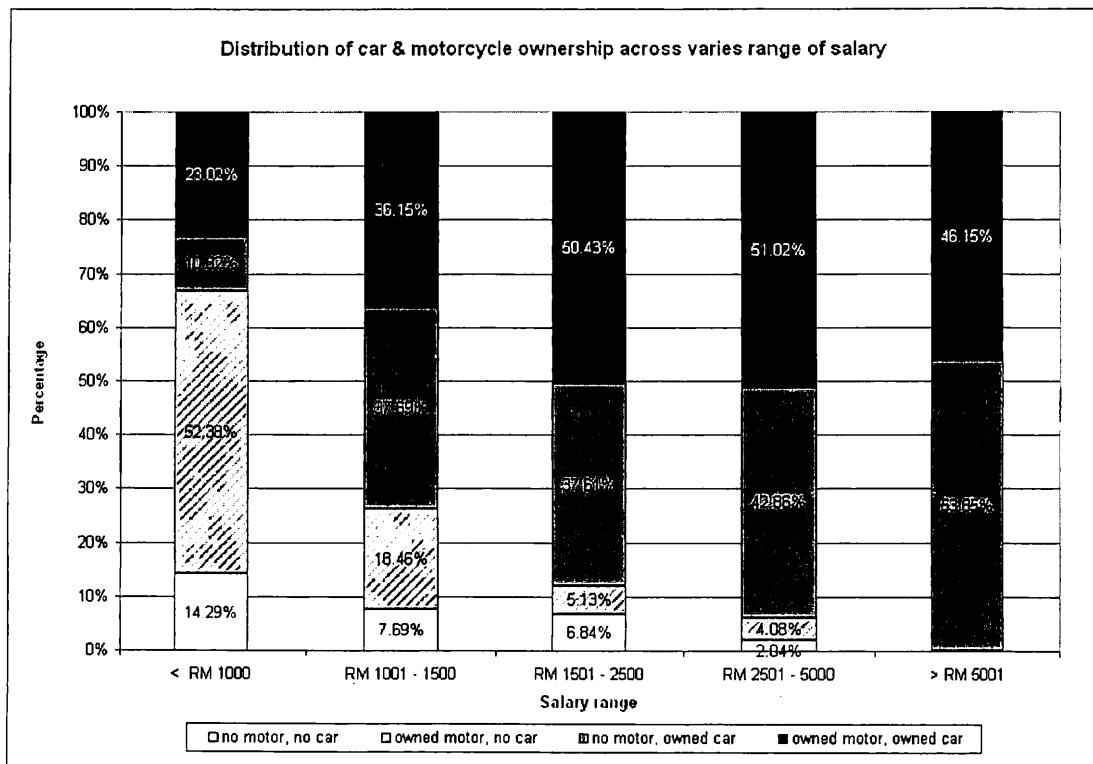


Figure 5: Distribution of motorcycles and cars ownership with income.

Figure 6 shows the total monthly expenditures on transportation. Majority of those surveyed spent less than 10% of their monthly income of transportation.

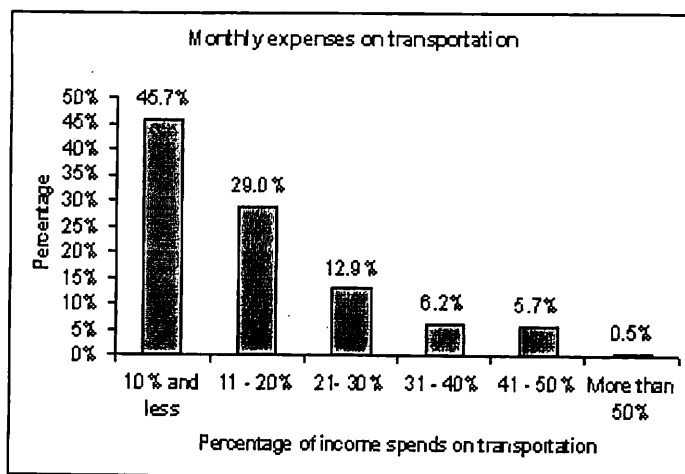


Figure 6: Monthly expenses on transportation

From the questionnaire survey conducted, based on a total of 435 respondents, 135 respondents (31.0%) do not own a car and 171 respondents (39.3%) do not own a motorcycle. Therefore, from 69% of the respondents who own at least 1 car and 60.7% respondents who own at least 1 motorcycle, the comparisons between car and motorcycle usage are as shown in Figure 7. Based on Figure 7, the main commuting purpose is to travel to work and followed by recreation.

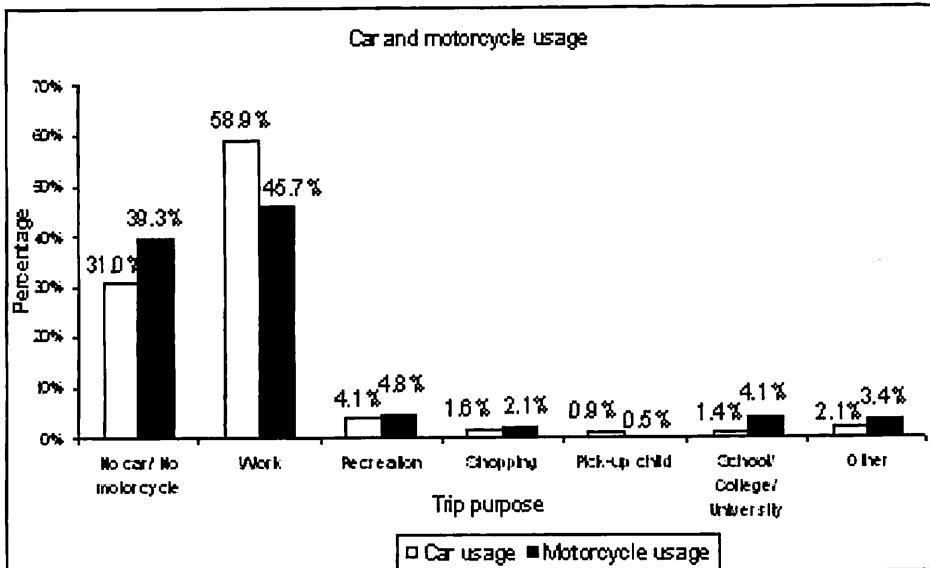


Figure 7: Car and motorcycle usage

Figure 8 shows the commuting distance for car trips and motorcycle trips. Based on Figure 8, majority of the respondents traveled less than 10 km which means to say that most of the respondents live near the workplace.

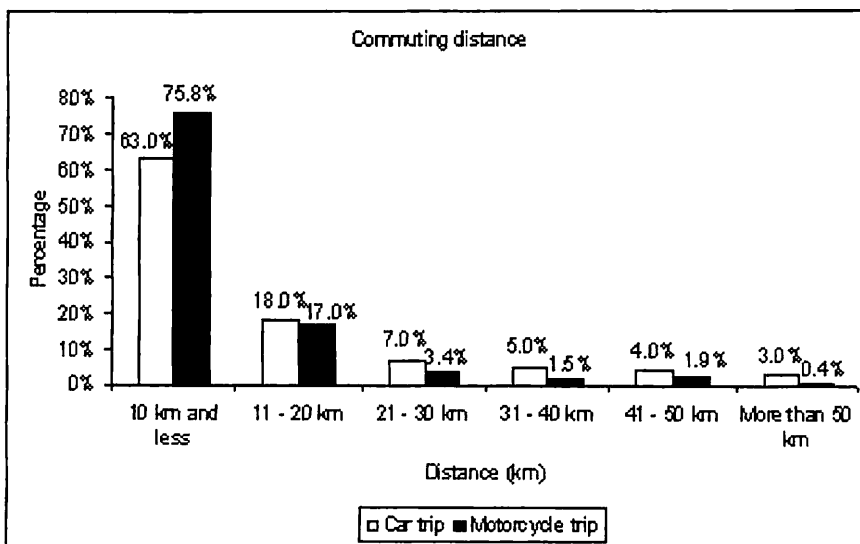


Figure 8: Commuting distance

Figure 9 shows the total number of family members in the household. Based on Figure 9, majority of the households surveyed have 4 to 5 family members and on the average, the household size is 4.4 people.

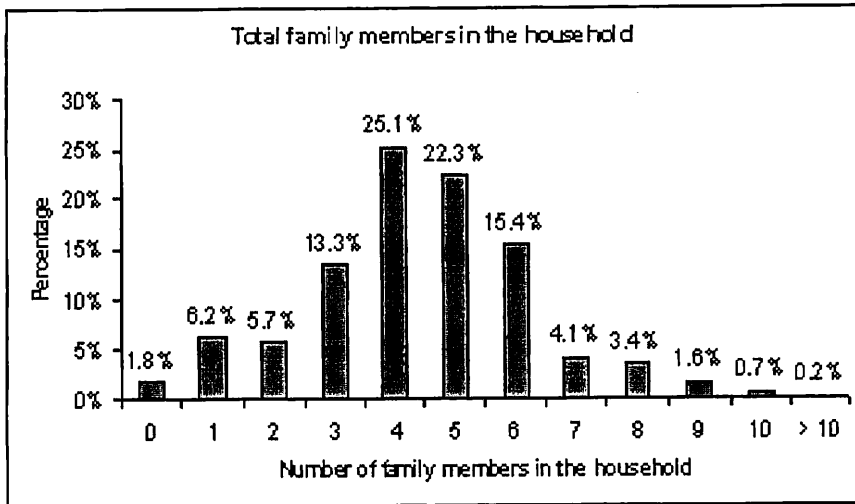


Figure 9: Total family members in the household

Figure 10 shows the total monthly income in the household. Based on Figure 10, majority of the households surveyed have a total income of RM 2501 to RM 5000.

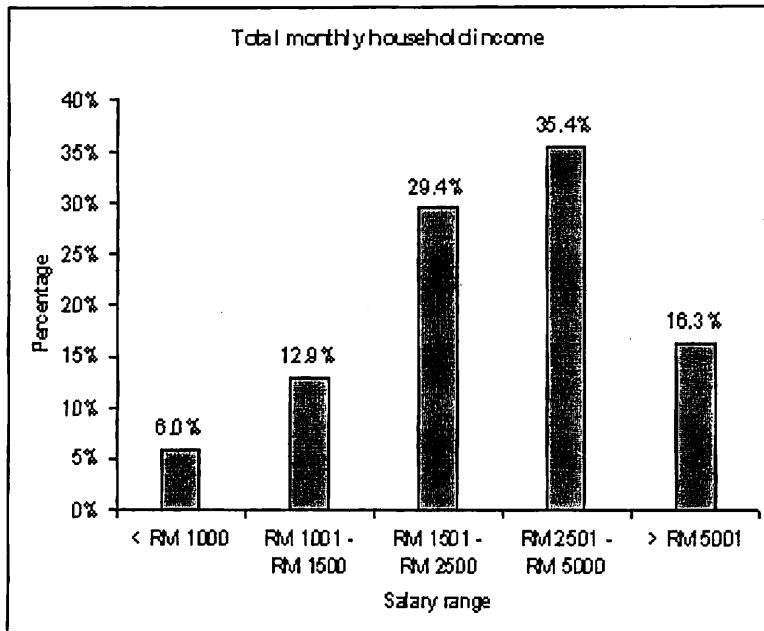


Figure 10: Total monthly household income

Figure 11 shows the total number of cars in the household. Based on Figure 11, majority of the households surveyed have 1 to 2 cars and the average number of cars in a household is 1.62 cars per households.

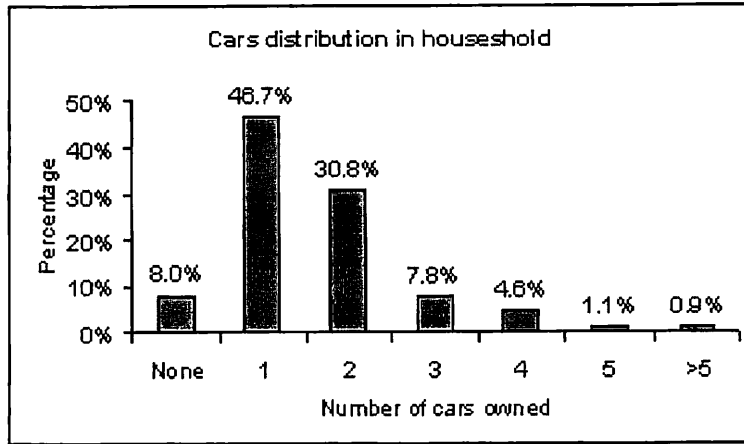


Figure 11: Total number of cars in households

Figure 12 shows the total number of motorcycles in the household. Based on Figure 12, majority of the households surveyed have 1 to 2 motorcycles and the average number of motorcycles in a household is 1.43 motorcycles per households.

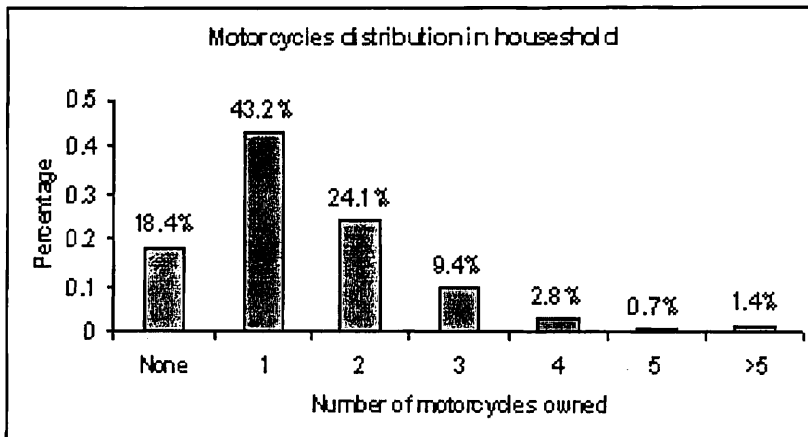


Figure 12: Total number of motorcycles in households

Figure 13 shows the total number of family members in the surveyed household that have car driving license. Based on Figure 13, on the average, there are 2.53 car driving license holders in the households.

Figure 14 shows the relationship between motorcycles and cars ownership with income for the households surveyed.

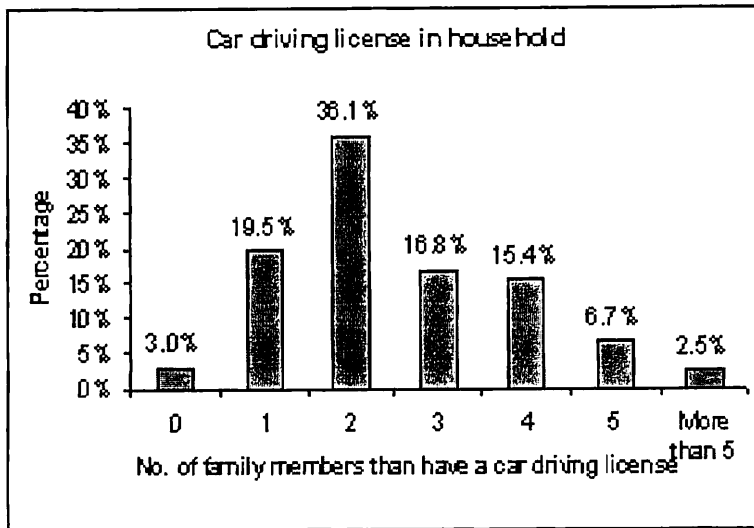


Figure 13: Total number of car license holders in households

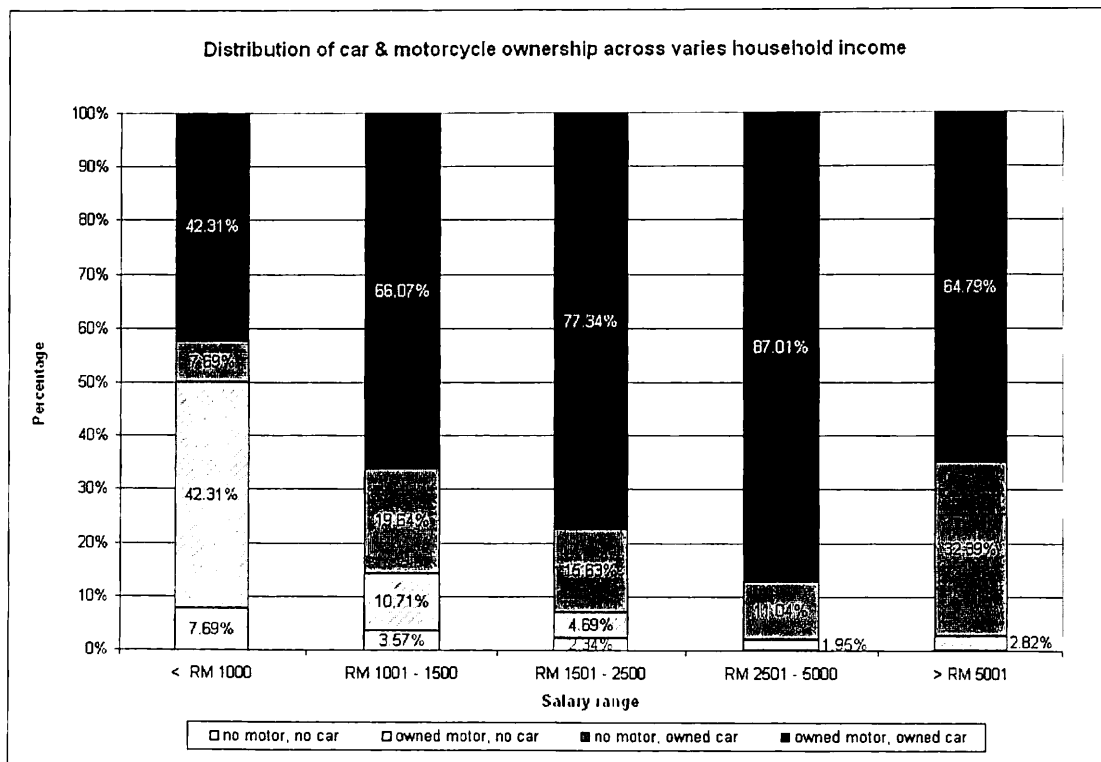


Figure 14: Distribution of motorcycles and cars ownership with total household income.

Figure 15 shows the total number of family members in the surveyed households that have motorcycles driving license. Based on Figure 14, on the average, there are 2.06 motorcycles driving license holders in the households.

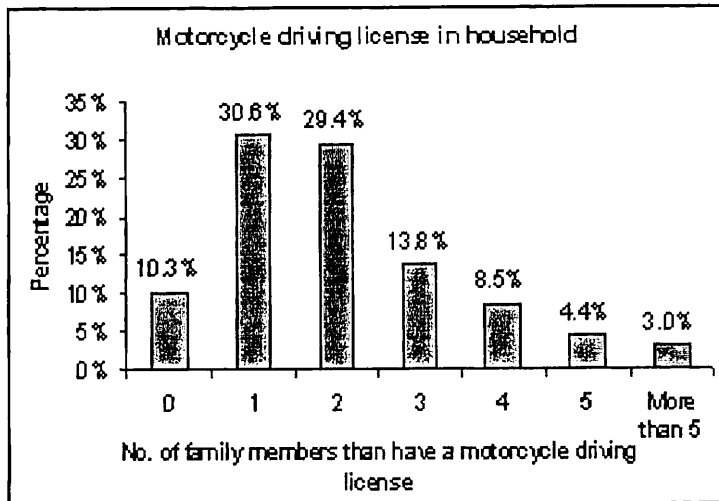


Figure 15: Total number of motorcycle license holders in households

Therefore, based on the results obtained from the survey, disaggregate choice models for motorcycle ownership were developed using the statistical software known as *SPSS*.

#### 4. DISAGGREGATE CHOICE MODELS FOR MOTORCYCLE OWNERSHIP

Disaggregate choice models using multinomial logistic regression for motorcycle ownership was developed separately for individual motorcycle ownership and household motorcycle ownership. This is to explore the differences of explanatory variables used to develop the individual motorcycle ownership and household motorcycle ownership models.

##### 4.1 Disaggregate choice model for individual motorcycle ownership

The explanatory variables used in the model and the coefficients obtained are as shown in Table 5 and the reference category is no motorcycle. The explanatory variables have been chosen to maximize model fit. Commuting distance and marital status was found to be insignificant and therefore were removed from the model. In this model, upon conducting various analyses using different combinations of income groups, it can be concluded that only 3 income groups that are significant. They are the low income (< RM 1000), medium income (RM 1001 – RM5000) and high income (>RM 5001).

Table 5: Individual motorcycle ownership results

Terms on the 1 motorcycle alternative	Coefficients	Sig.
Intercept	-1.721	0.038
Age	0.031	0.016
Monthly expenditure on transportation	-0.029	0.002
Individual income: Low (<RM 1000)	1.466	0.038
Individual income: High (> RM 5001)	0*	-
Individual car ownership: 1 car	-0.593	0.048
Individual car ownership: 2 plus cars	-1.105	0.031
Individual car ownership: No car	0*	-
Race: Bumiputras	0.547	0.028
Race: Non-bumiputras	0*	-
Gender: Male	1.518	0.000
Gender: Female	0*	0*
Terms on the 2 plus motorcycles alternative	Coefficients	Sig.
Intercept	-5.585	0.000
Monthly expenditure on transportation	-0.040	0.046
Individual income: Low (<RM 1000)	2.141	0.094
Individual income: High (> RM 5001)	0*	-
Individual car ownership: 2 plus cars	2.530	0.006
Individual car ownership: No car	0*	-
Gender: Male	1.014	0.034
Gender: Female	0*	0*
<b>Pseudo R-square</b>		<b>0.288</b>

Note: \* This parameter is set to 0 because it is redundant given the intercept term.

In Table 5, only parameters with significance values less than 0.05 (at 95% confidence interval) were shown. If the significance level is small (less than 0.05) then the parameter is different from 0. Therefore, parameters with significance values more than 0.05 were removed from the model.

Parameters with positive coefficients increase the likelihood of that response category and parameters with significant negative coefficients decrease the likelihood of that response category with respect to the reference category. Therefore, based on Table 5, for the one motorcycle alternative, negative coefficients were observed for both groups of car ownership. This shows that car ownership decreases the likelihood of owning a motorcycle. However, for the case of two plus motorcycles alternative, coefficients for the 2 plus cars are positive which means that for an individual who owns 2 or more cars, they are more likely to own 2 or more motorcycles. This situation occurred may be because this group of individuals belongs to the high income group. Apart from that, monthly expenditure on transportation also decreases the likelihood of motorcycle ownership.

#### 4.2 Disaggregate choice model for household motorcycle ownership

The explanatory variables used in the model and the coefficients obtained are as shown in Table 6 and the reference category is no motorcycle. Household car ownership was found to be insignificant and was removed from the model.

Table 6: Household motorcycle ownership results

Terms on the 1 motorcycle alternative:	Coefficients	Sig.
Intercept	-2.228	0.000
Household income: < RM 1000	1.997	0.007
Household income: RM 1001 – RM 1500	1.299	0.031
Household income: RM 1501 – RM 2500	1.197	0.009
Household income: RM 2001 – RM 5000	1.178	0.007
Household income: > RM 5000	0*	-
Household members: > 6 persons	2.104	0.003
Household members: 3 – 6 persons	1.647	0.000
Household members: 1 – 2 persons	0*	-
Household car license holder: 1 person	-1.595	0.002
Household car license holder: 2 persons	-0.977	0.017
Household car license holder: 3 persons and more	0*	-
Household motorcycle license holder: 1 person	2.489	0.000
Household motorcycle license holder: 2 person	2.177	0.000
Household motorcycle license holder: 3 persons and more	0*	-
Terms on the 2 plus motorcycles alternative:	Coefficients	Sig.
Intercept	-2.335	0.000
Household income: < RM 1000	2.399	0.004
Household income: RM 1001 – RM 1500	2.666	0.000
Household income: RM 1501 – RM 2500	1.756	0.000
Household income: RM 2001 – RM 5000	1.739	0.000
Household income: > RM 5000	0*	-
Household members: > 6 persons	2.941	0.000
Household members: 3 – 6 persons	2.528	0.000
Household members: 1 – 2 persons	0*	-
Household car license holder: 1 person	-1.539	0.003
Household car license holder: 2 persons	-1.399	0.001
Household car license holder: 3 persons and more	0*	-
Household motorcycle license holder: 1 person	-1.172	0.026
Household motorcycle license holder: 2 person	1.084	0.010
Household motorcycle license holder: 3 persons and more	0*	-
<b>Pseudo R-square</b>		<b>0.451</b>

Note: \* This parameter is set to 0 because it is redundant given the intercept term.

As mentioned before, parameters with positive coefficients increase the likelihood of that response category and parameters with significant negative coefficients decrease the likelihood of that response category with respect to the reference category. Hence, the negative coefficients for household car license holder categories in Table 5 shows that households with at least one person having a car driving license will decrease the likelihood of owning any motorcycle. As well as for the 2 plus motorcycles alternative, if there is only one motorcycle license holder in a household, the likelihood of owning two motorcycles will decrease.

## 5. CONCLUSION

Motorcycles, due to its small size and high maneuverability are a useful mode of transportation for commuting within the city area especially during traffic congestion. In Malaysia, there are approximately 5.8 million motorcycles on the roads as compared to 5 million passenger cars. Motorcycle ownership has also increased from



0.13 in year 1990 to 0.24 motorcycles per person in year 2002. Based on the survey conducted, motorcycles will continue to be one of the major modes of transportation in the near future especially among the low and middle income group people. Therefore, development of a motorcycle ownership model based on local travel demand is essential in order to have a better understanding on the trend of motorcycles ownership and the nature of motorcycle travel demand. By having this information, a better perspective to the future planning and development of traffic system could be carried out. This will assist in the identification of suitable strategies and countermeasure to address motorcycles traffic issues thus improving the safety and performance of traffic system in Malaysia.

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**A new thinking for modeling motorcycle ownership forecasting model:**

**Perspective to a Stepwise Structure of Modeling Motorcycle Ownership of Developing Countries**

**Hsu, Tien-Pen**

**National Taiwan University**

**22 Sept 2005**

**Question 1:**

**Motorcycle growing with the GDP or GDP growing with the motorcycle?**

- **If motorcycle growing with the GDP, then the motorcycle will never reduce; if GDP growing with the motorcycle, in someday, the motorcycle will be substituted by car due to high income level.**

**Question 2: when the ownership of motorcycle will decrease?**

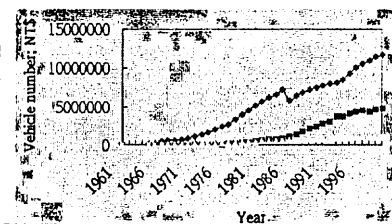
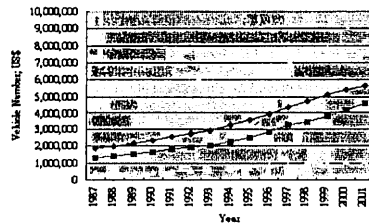
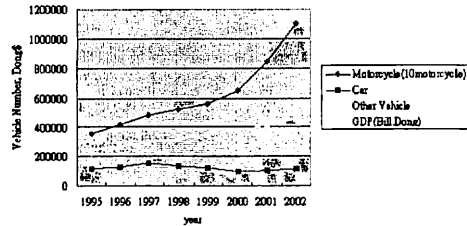
# Existing development stage: Growth Rate

Vietnam: Motorcycle > Car > GDP

Malaysia: Car > Motorcycle = GDP

Taiwan: Motorcycle = Car = GDP

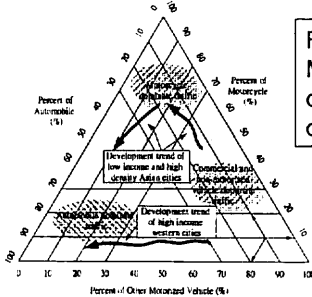
Growth rate	Motor cycle	Car	GDP
Vietnam	29.6%	9.6%	5.8%
Malaysia	4.7%	9.9%	4.2%
Taiwan	2.7%	2.3%	3.5%



The society with motorization structure from Motorcycle to Automobile

The development stage is changing

From Motorcycle oriented to Car oriented

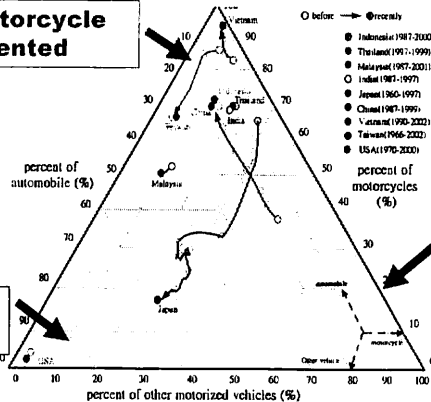


Motorized structure: Proportion of Car, Motorcycle and other Motorized Vehicle

Motorcycle oriented

Car oriented

Commercial Vehicle oriented



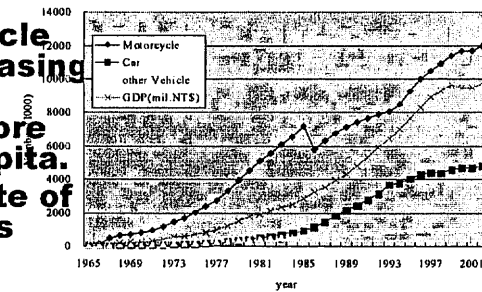
## **Substitute between Car and Motorcycle, dependent**

- **1. the income level, can afford both, or only one.**
- **2. the traffic congestion level, advantage of not be stopped by jam, and easy to find park space.**
- **3. sometimes, the substitution phenomenon is significant, sometimes is not significant**
- **4. To buy a motorcycle first, then to buy a car, furthermore, to have a car and a motorcycle (63% of Household has motorcycle and car at the same time)**
- **5. Forecasting follows the tendency and expect to the future with the same development structure**  
**According to the model, the motorcycle will never decrease**

## **Motorcycle ownership will decrease, but car ownership will never decrease**

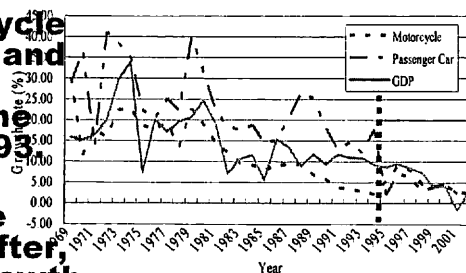
- **According to the development in some developed countries, and according to general sense, if the economic level reach certain high grade, the motorcycle ownership will decrease.**
- **When will the motorcycle ownership start to decrease: It depends on the other factors: such as public transport, population density, traffic policy and traffic situation.**
- **To distinguish the development stages may be necessary**

- in Taiwan, the motorcycle number is still on increasing even that the personal income has reached more than US\$12,000 per capita.



- Figure 1, the growth rate of motorcycle number was greater than that of passenger car and also higher than the economic growth rate before 1969.

- Thereafter, the motorcycle growth rate decreases and becomes less than the passenger car during the period from 1970 to 1993.

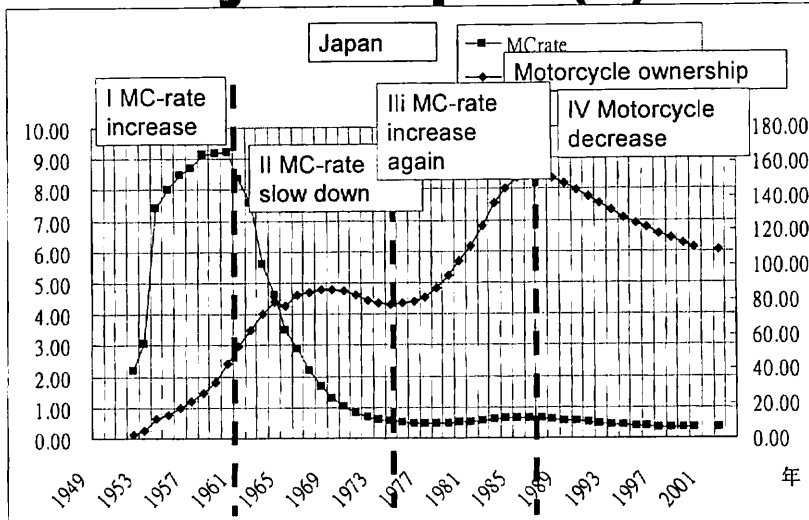


- in recent years, the motorcycle growth rate increases again thereafter, and is closing to the growth rate of passenger car, as shown in Figure 2

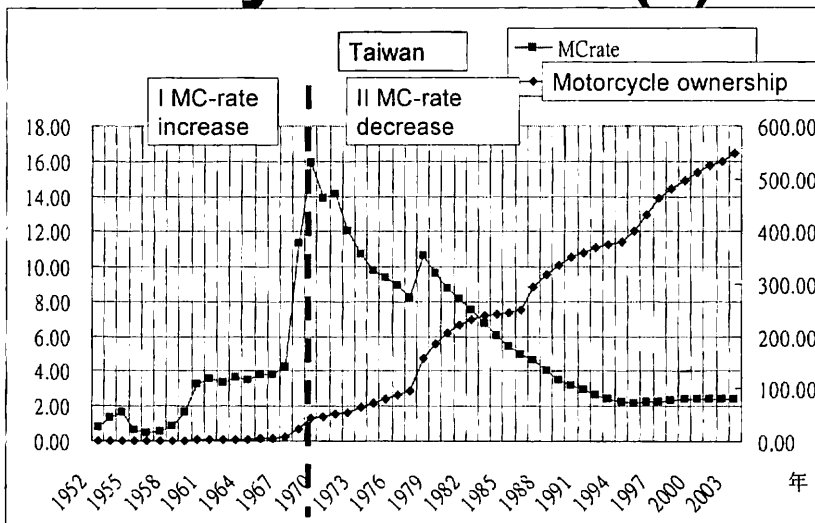
## New Parameter MC-Rate

- **MC-rate =**  
**Motorcycle ownership/ Car ownership**
  1. MC-rate > 1.0, means motorcycle ownership is larger than car ownership
  2. MC-rate increasing, means motorcycle ownership growth rate is greater than car ownership
  3. MC-rate decreasing, means motorcycle ownership growth rate is less than car ownership
  4. MC-rate < 1.0, means motorcycle ownership is less than car ownership

# History in Japan (1)



# History in Taiwan (1)

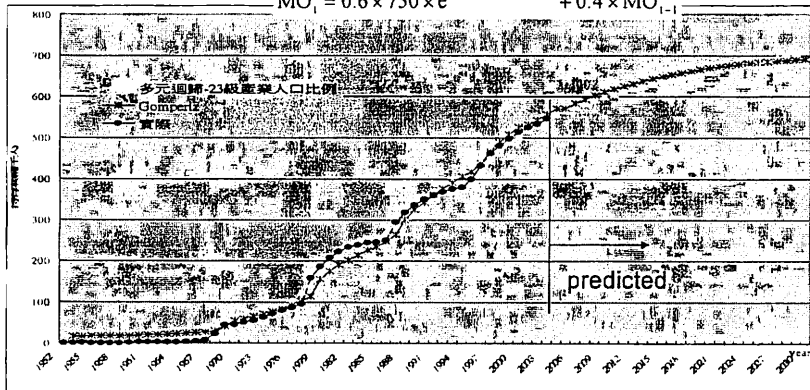


# Ownership of Motorcycle

According to the model, motorcycle will never decrease

$$MO_t = -1078.38 + 0.777 \times \text{Pop} - 3.907 \times P_{acc,t}$$

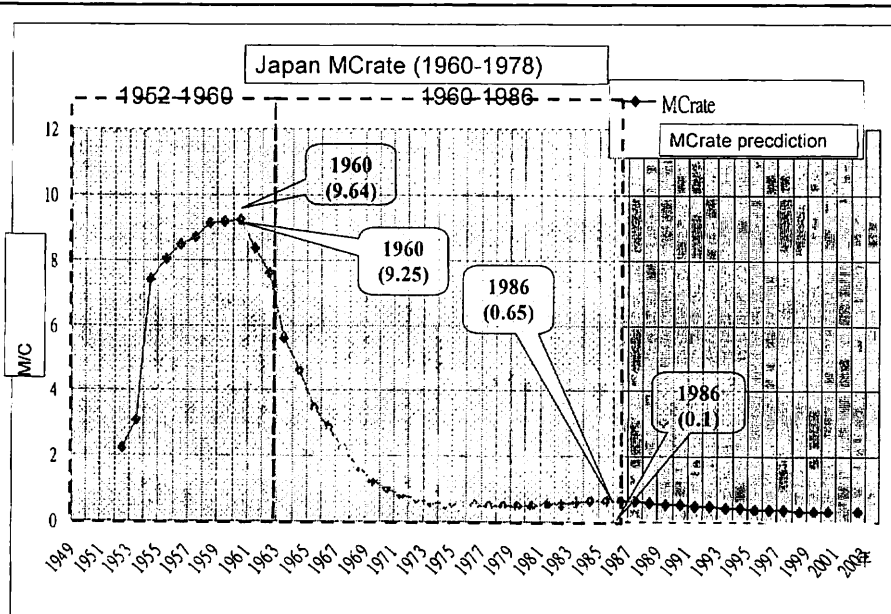
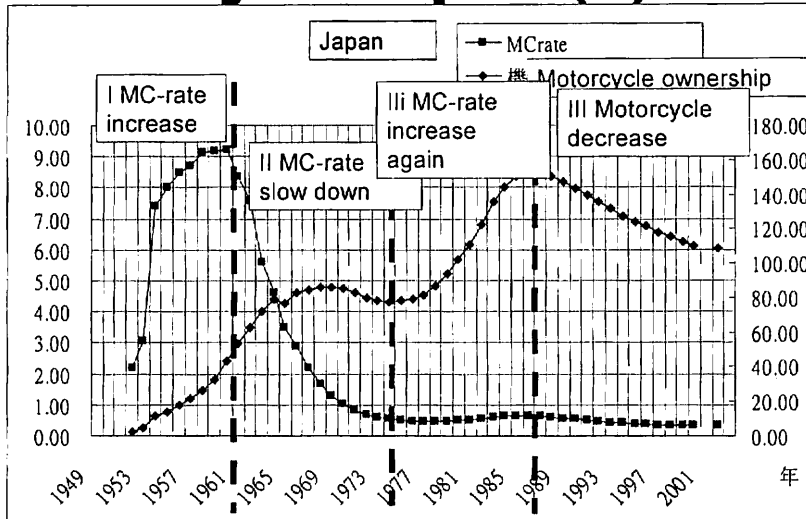
$$MO_t = 0.6 \times 750 \times e^{-1.388 \times e^{-0.0002 \times \text{GDP}}} + 0.4 \times MO_{t-1}$$



## The stepwise forecasting

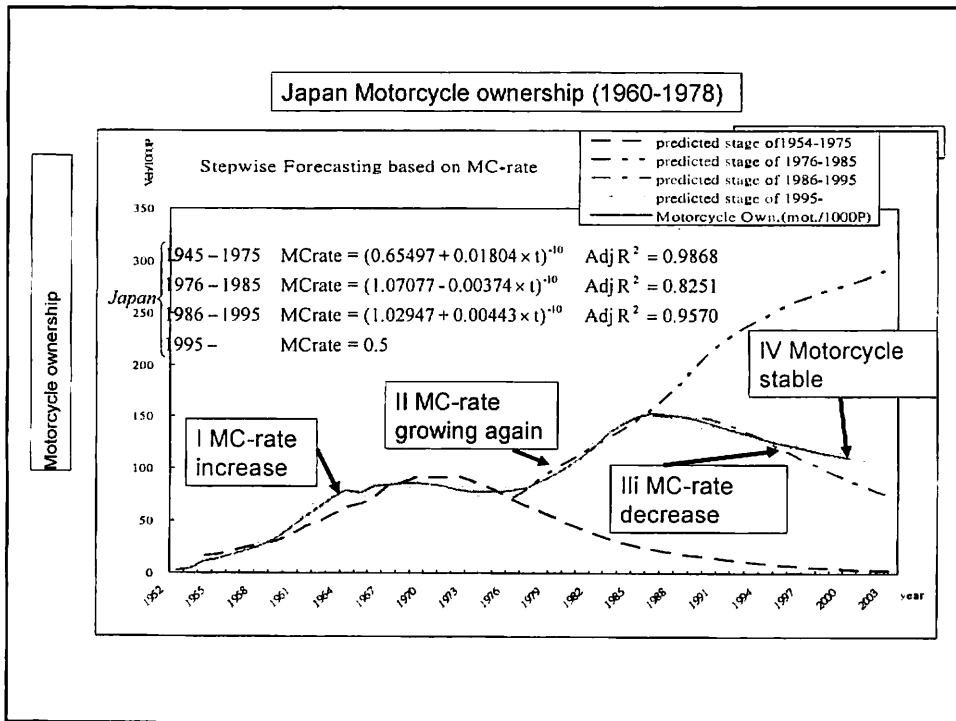
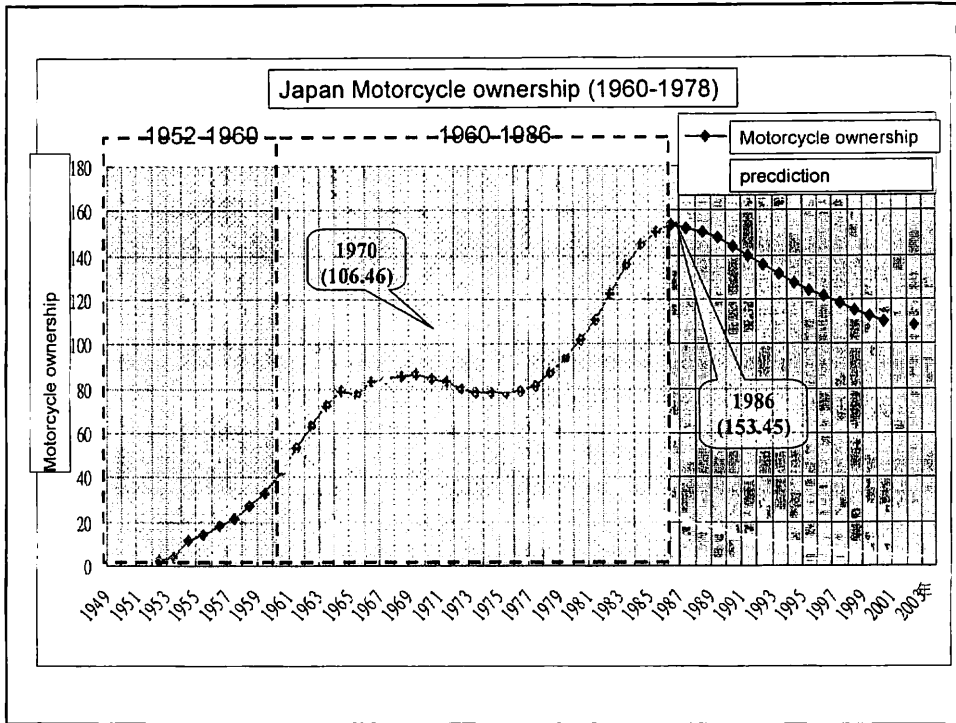
- 1. to identify the stage I or II & III
- 2. to establish the time series model of MC-rate, or a regression model for different stage and then predict the MC-rate
- 3. to establish the prediction model of car ownership, because the car ownership will increase continuously
- 4. to calculate the motorcycle predicted amount of motorcycle using MC-rate model by input of the car ownership.

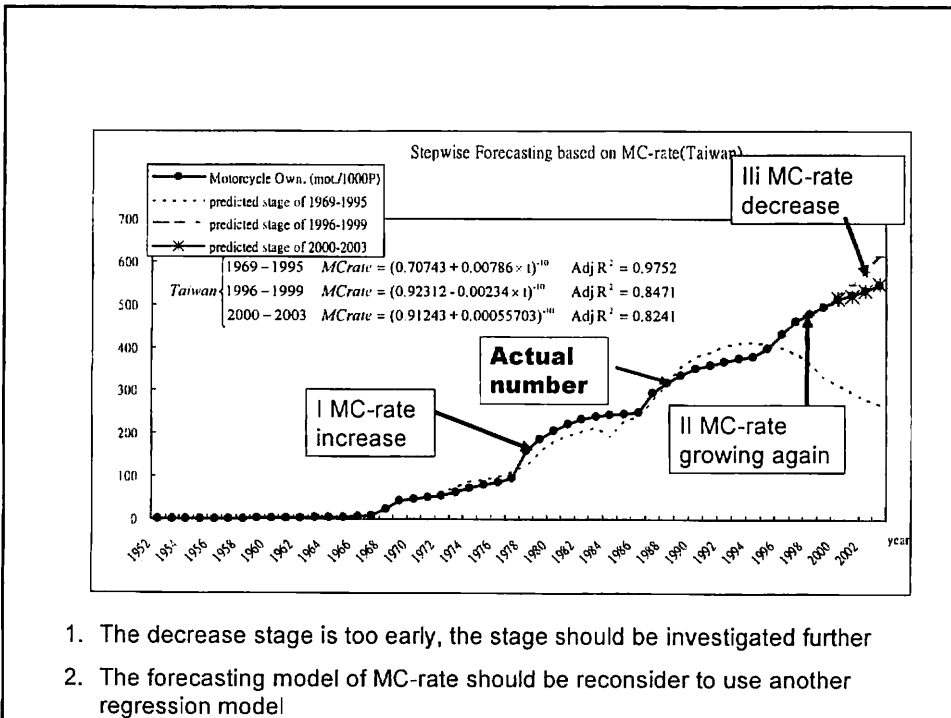
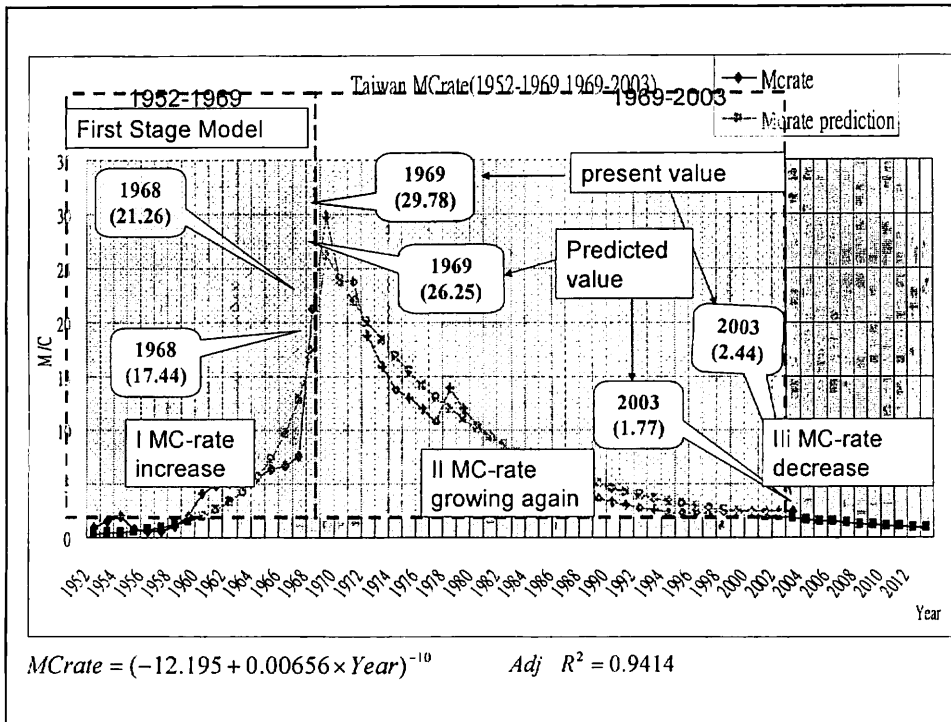
# History in Japan (1)



$$MCrate = (-34.326 + 0.018 \times Year)^{-10} \quad Adj R^2 = 0.9671$$

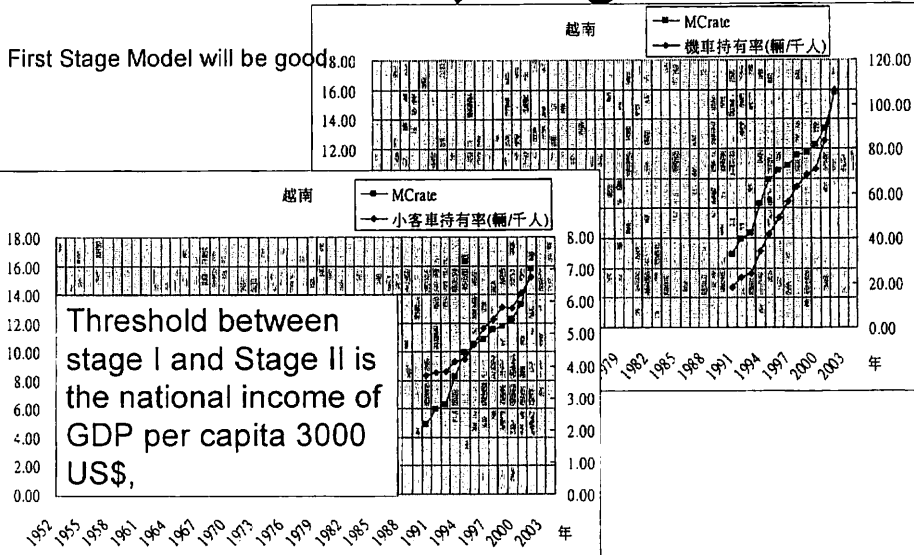




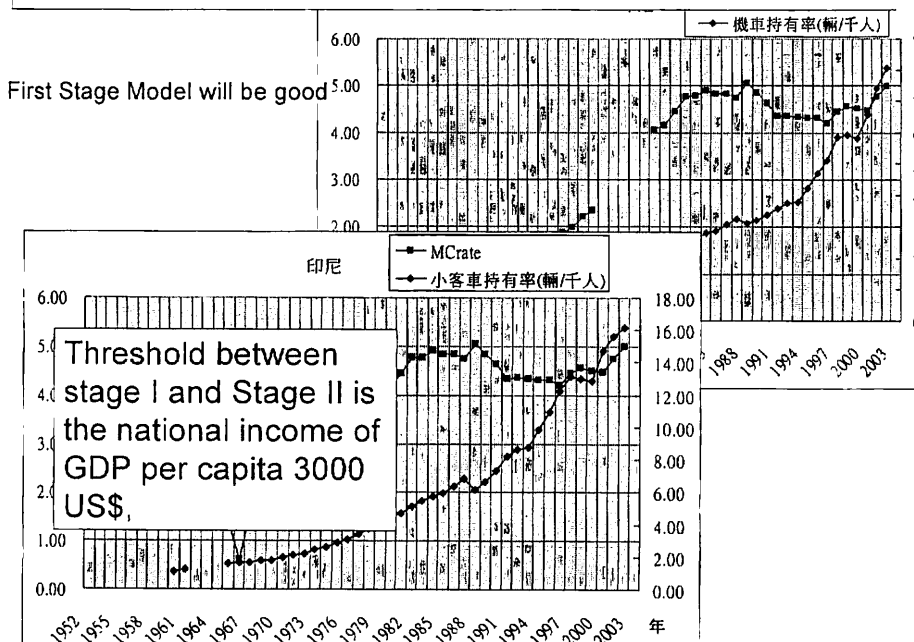


1. The decrease stage is too early, the stage should be investigated further
2. The forecasting model of MC-rate should be reconsider to use another regression model

# Vietnam case, Stage I.

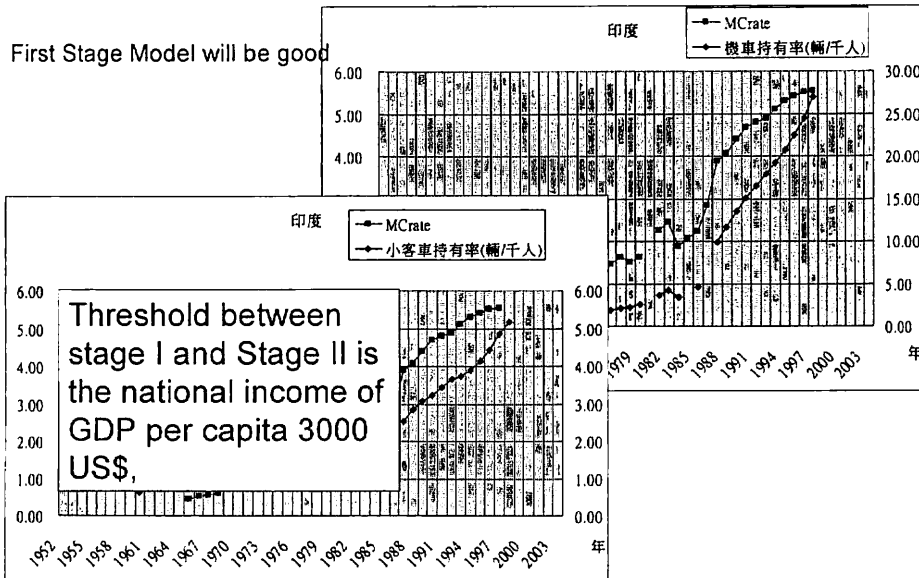


# Indonesian case, between Stage I and II.



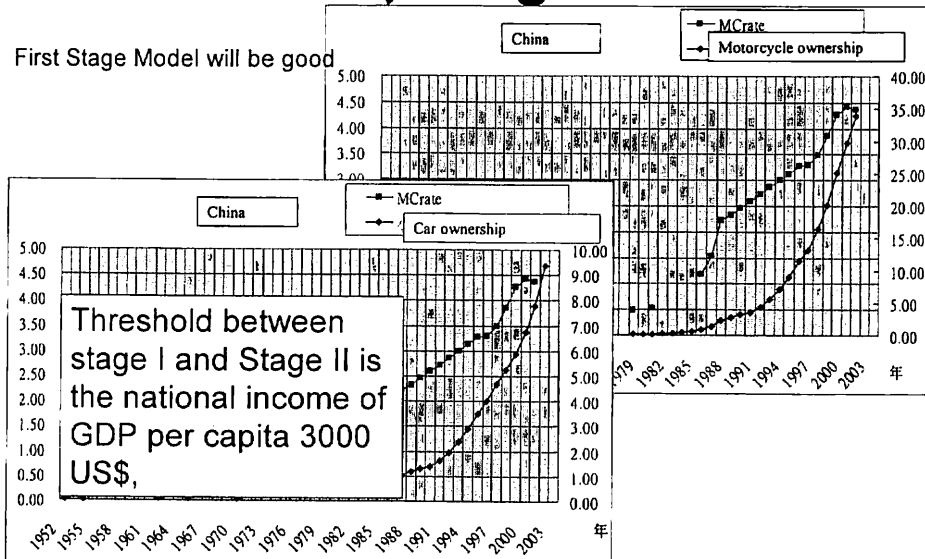
# India case, Stage I-II.

First Stage Model will be good



# China case, Stage I-II.

First Stage Model will be good



## **Conclusion and Suggestion**

- **To identify the stage is necessary. To find out when the motorcycle ownership will decrease**
- **To establish the suitable model for every stage may enhance the accuracy of the forecasting.**
- **There are a number of the factors which will influence the stage threshold. It needs to be investigated further. The public transport service, the traffic congestion situation and the policy of vehicle regulation.**
- **However, the motorcycle traffic needs more care and more effort to improve it.**

**To understand it and then be able to live with it peacefully – Motorcycle needs more understanding**

## **Thank you for your joining the motorcycle session**

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